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Measurements of Particulates, Metals, and Organics at a Hazardous Waste Incinerator

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The EPA's Office of Solid Waste is developing amendments to regulations for hazardous waste incinerators. OSW, is gathering additional data relative to these amendments. Several issues arose during development of the amended regulations that required this data gathering. The issues related to control device efficiency for particulate and toxic metals and to the use of total hydrocarbon monitors to measure organic emissions. This report describes the field tests at a hazardous waste incinerator that is part of this data-gathering effort. The types of data collected during this test are particulate emissions, particle size, selected toxic metals emissions and their control device efficiency, and organic emissions. This report is divided into four section: a brief summary of the conclusions; a description of the

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MEASUREMENTS OF PARTICULATES, METALS, AND ORGANICS AT A HAZARDOUS WASTE INCINERATOR

DRAFT FINAL REPORT

U.S. Environmental Protection Agency
Office of Solid Waste
Waste Treatment Branch
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SECTION 1.0

INTRODUCTION

The Environmental Protection Agency's Office of Solid Waste (EPA/OSW) is developing amendments to regulations for hazardous waste incinerators. OSW, supported by the Hazardous Waste Engineering Research Laboratory, is gathering additional data relative to these amendments. Several issues arose during development of the amended regulations that required this data gathering. The issues related to control device efficiency for particulate and toxic metals and to the use of total hydrocarbon monitors to measure organic emissions.

This report describes the field tests at a hazardous waste incinerator that is part of this data-gathering effort. The types of data collected during this test are particulate emissions, particle size, selected toxic metals emissions and their control device efficiency, and organic emissions. Testing was conducted at the Mobay Corporation facility in Kansas City, Missouri.

The remainder of this report is divided into four sections. Section 2.0 is a brief summary of the conclusions derived from this study. Section 3.0 presents a description of the program including the program objectives, incineration process description, sampling and analysis procedures, and data reduction. A discussion of the results of this study is provided in Section 4.0. Two appendices contain additional information as follows: Appendix A presents a detailed discussion of the sampling and analysis methods used in the study and the associated quality assurance activities; and Appendix B provides the experimental data from the study.

SECTION 2.0

CONCLUSIONS

This section contains brief statements of the major conclusions determined from analysis of the data generated during this project. Further discussion of these conclusions and other aspects of the data are presented in Section 4.0. The conclusions below are divided into two categories: those related to emissions from and performance of the incineration facility, and those related to the measurement methods used on the project.

2.1 FACILITY EMISSIONS AND PERFORMANCE

1. Particulate concentrations in the stack gas after the venturi/packed-bed scrubber at this facility (operated at a pressure drop of 50 in water) were about 0.02 grains per dry standard cubic foot (corrected to 7% oxygen) and the estimated particulate removal efficiency was greater than 98%. Carry over of salts from the caustic scrubber to the stack may have increased the measured particulate emissions and decreased the estimated efficiency.

2. Eighty-two percent of the particles emitted from the stack were found to be less than 1 µ in size. The carry over of salts from the scrubber may have been primarily 1 µ or less particles, thus increasing the proportion of mass collected in this size range.

3. The estimated control system removal efficiencies for metals averaged 98.8% for arsenic, 98.6% for cadmium, 99.2% for chromium, and 96.3% to 97.8% for lead.

4. The distribution of metals in the stack gas by particle size showed that most of the mass of each metal was in the less than 1-μ size range. The fraction of total metal in this size range varied from 54% for cadmium to 88% for lead.

5. Most of the organic mass in the stack gas (80.7% average), as measured by the EPA Level 1 techniques, was C_1-C_7 volatile compounds. About 50% of the mass was volatile compounds collected in a condensate trap on the sampling line for the gas bag sampling train.

6. Barely detectable levels of formaldehyde were found in the stack gas, about 1 ppm.

7. Very small quantities of C_1-C_2 compounds were found in the stack gas when the incinerator was operated at CO levels of 1000 ppm or less. At the higher CO levels, up to 30 ppm of methane (calculated as ppm propane) was found. Two ppm or less of ethane, ethylene, or acetylene were found during operation at any of the tested CO levels.

8. Total hydrocarbons (THC) measured with a heated sample line and monitor were 3 to 10 (one value at 27) times higher than THC measured simultaneously with a similar but unheated sample line and monitor. The difference between these results is partially explained by a high bias for the hot THC measurements and organic compounds collected in a cold condensate trap on the sampling line for the cold THC measurements. However, the difference could not be fully explained with the available data.

9. The hot THC monitor measured 2 to 8 times more organic mass than the EPA Level 1 measurements. This difference was believed to be mostly explained by the high bias for the hot THC measurements and a low bias for the Level 1 measurement. The low bias for the Level 1 measurement resulted from certain portions of the organic compounds that could not be resolved during the gas chromatographic analyses.

10. Measured values from both the hot and cold THC monitors tended to increase as the stack gas CO concentrations increased.

2.2 MEASUREMENT METHODS

1. The sampling method used to collect chromium +6 failed to provide valid samples. This may have resulted from reduction of the chromium +6 to chromium +3 by sulfur compounds collected in the samples.

2. As anticipated at the start of the project, the use of stainless steel in the particle size sampling train appeared to contaminate those samples with chromium.

3. Considerable problems were experienced with plugging of the sample line to the hot THC monitor and within the monitor. This caused a high bias in the data and made continuous operation of the monitor difficult.

4. Modification of the Level 1 techniques used on this project are needed to avoid problems that prevented measuring all of the organic mass. The primary problem was masking of C_7-C_9 organic compounds by the extraction solvents.

SECTION 3.0

PROJECT DESCRIPTION

This section presents the project objectives, summary descriptions of the process and sampling and analysis, and a discussion of data reduction.

3.1 PROJECT OBJECTIVES

The specific objectives of the test were as follows:

1. Determine the level of particulate matter emissions from a venturi scrubber/packed bed scrubber system at the test facility.

2. Determine the metals removal efficiency for the air pollution control system (from metals feed rates and stack emission rates); analysis of the scrubber effluent will be used to provide an approximate mass balance check.

3. Determine the particle size distribution of the particulate in the stack emissions and the distribution of metals by particle size. The particulate size fractions of interest are those which have been determined by EPA to be the major contributor to inhalation health effects and to atmospheric deposition.

4. Evaluate the following emission measurements over a range of incinerator operating conditions that result in carbon monoxide (CO) levels in the range from 100 to 2,500 ppm.

   a. Heated total hydrocarbon (THC) as recommended for the regulation amendments vs. "Level 1" total organic mass

b. Heated THC vs. unheated THC (similar to past THC measurements at incinerators)

c. Heated THC vs. CO

Section 3.3.2 describes the heated and unheated THC measurements.

3.2 PROCESS DESCRIPTION

The facility selected for this test consists of a John Zink, down-fired, liquid-injection hazardous waste incinerator with a venturi/packed-bed wet scrubber system. The following discussion briefly describes the incinerator, the scrubber, and the operating conditions during testing. Figure 3-1 shows a process flow diagram for the facility. The six sampling locations used during this test are marked on Figure 3-1 as S1-S6.

3.2.1 Incinerator Description

The incinerator has a single vertical combustion chamber with aqueous and liquid organic waste, auxiliary fuel, and a lean waste gas stream cofired down from the top of the chamber. Natural gas or fuel oil can be used as the auxiliary fuel. The incinerator has a design thermal capacity of 45 x 10^6 Btu/h. The initial section of the combustion chamber (4-ft long by 4-ft diameter) has an external air atomized burner for the organic waste and burners for the auxiliary fuel. The section is designed to produce a high intensity flame. The chamber then transitions to a second section 8 ft in diameter by 32-ft long. A ring of 10 nozzles are located in the transition to feed the aqueous waste and tempering water. The overall residence time for the combustion chamber is about 2 s. The combustion gases pass from the bottom of the combustion chamber through a submerged quench to the air pollution control system.

The aqueous waste feed has a nominal feed rate of 10 to 12 gal/min (gpm) at 40 to 60 psig. It has a specific gravity of 1.04, a pH of about 10, and contains about 3% ash. The organic waste has a nominal feed rate of 5 to 6 gpm at 10 to 30 psig with a higher heating value (HHV) of 12,000 to 16,000 Btu/lb.

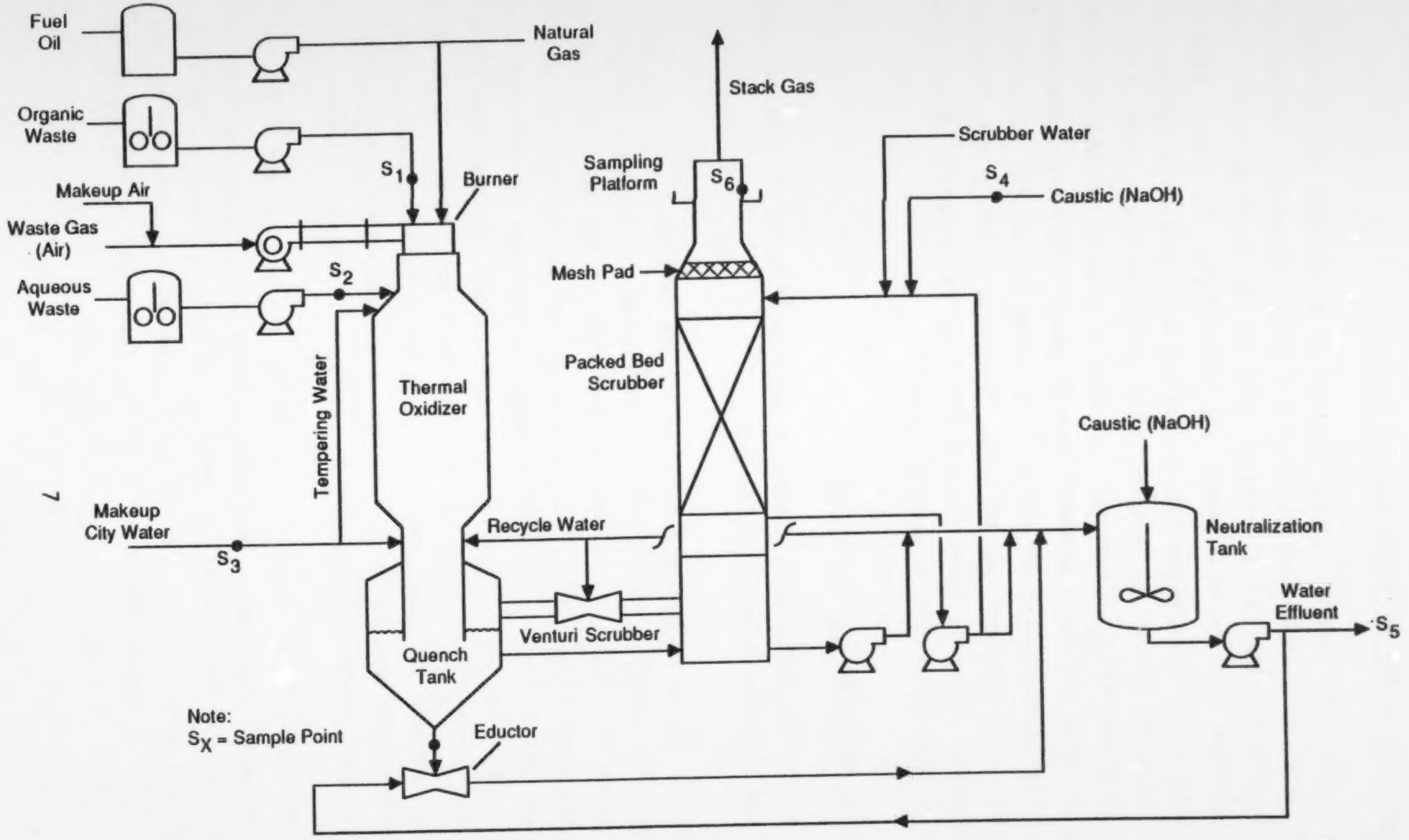
Fuel Oil
Organic Waste
Makeup Air
Waste Gas (Air)
Aqueous Waste
Natural Gas
Burner
S_1
S_2
Tempering Water
Thermal Oxidizer
Makeup City Water
S_3
Quench Tank
Note:
S_X = Sample Point
Eductor
Recycle Water
Venturi Scrubber
Stack Gas
Sampling Platform
S_6
Mesh Pad
Packed Bed Scrubber
Scrubber Water
S_4
Caustic (NaOH)
Caustic (NaOH)
Neutralization Tank
Water Effluent
S_5

Figure 3-1. Process flow diagram.

3.2.2 Description of Air Pollution Control System

The air pollution control system consists of a variable throat venturi scrubber followed by a packed-bed scrubber and mist eliminator. The venturi scrubber normally operates at a pressure drop of 40 to 45 in water. The packed-bed scrubber is 8 ft in diameter and 25-ft high. It uses a caustic solution countercurrent to the gas flow to collect acid gases. It operates at a pressure drop of 10 to 12 in water with polypropylene, Super Intalax Saddles™ packing materials. A mesh-pad type mist eliminator is located at the exit of the scrubber and has a pressure drop of about 1 in water. The scrubber system uses approximately 50 gpm of city water to maintain a constant caustic level. The scrubber gas effluent is saturated with water (nominal value of 55% water vapor) at approximately 180°F and has a nominal actual gas flow rate of 27,000 cubic feet per minute (acfm).

3.2.3 Facility Operation During Testing

Operation of the facility is discussed separately below for the metals/particulate and organics portions of the test.

3.2.3.1 Facility Operating During Metals/Particulate Testing--

The facility operated under normal conditions during the metals/particulate phase of testing. Natural gas was used as the auxiliary fuel. Nominal organic waste feed rate was 3 gpm, and aqueous waste feed rate was 6 to 7 gpm. The design of the incinerator makes it possible to evaluate the APCD control efficiency using combustion chamber input and measured stack output emission rates. All material in the combustion chamber is passed through the quench tank/scrubber system, as opposed to being removed as ash. Thus, if known metals quantities are spiked into the combustion chamber, measurement of stack emissions will provide a measure of APCD efficiency.

A measured quantity of arsenic trioxide (As_2O_3) was spiked into the stirred aqueous waste feed tank. Subsequent sample analysis showed arsenic levels to be approximately 3 mg/kg of water. The intended level of spiking was such that the quantities of each of the spiked metals collected in the metals train would be approximately 100 times the analytical method detection limit. This spike level was estimated from the aqueous waste feed rate, an assumed APCD control efficiency of 99%, the volumetric stack gas flow rate, and the total estimated metals train gas sample volume per run. The entire 27,000 gal aqueous waste feed tank was spiked and used for all three metals test runs.

Concentrated solutions (500-5,000 mg/kg water) of chromium, cadmium, and lead were prepared for each run and introduced into the tempering water line using an injector pump. $Cr(NO_3)_2 \cdot 9H_2O$, $Cd(NO_3)_2 \cdot 4H_2O$, and $Pb(NO_3)_2$ were used to prepare the spiking solutions. These compounds could not be spiked directly into the aqueous waste feed tank because of the potential for the formation of precipitates within the tank. This could affect the actual quantity of metal being pumped to the incinerator. The chromium level spiked in Run 3 (~ 10,000 mg/kg) is exactly double the amounts in Runs 2 and 4 (~ 5,000 mg/kg). The injection pump was not run during periods of incinerator operation when sampling was not being performed.

3.2.3.2 Facility Operation During Organics Testing--

During the organics phase of testing, the aqueous waste feed rate and tempering water flow rate were varied from run to run to achieve constant operation at the planned CO levels. The CO levels generally increased as the aqueous waste and tempering water feed rates increased. Organic waste feed rate and excess air levels remained relatively constant for Runs 5 to 7 and 10. During Runs 8 and 9, operating temperature and excess air levels, respectively, were varied while other facility operations remained normal. Six runs were conducted at the following conditions:

Run	Nominal CO level (ppm)	Temperature, excess O_2
5	100	Normal, normal
6	500	Normal, normal
7	1,000	Normal, normal
8	2,500	Low, normal
9	2,500	Normal, low
10	2,500	Normal, normal

For Run 5, fuel oil was used instead of natural gas for the auxiliary fuel. Natural gas was used again for Run 6, and no auxiliary fuel was used for Runs 7 through 10.

Process conditions were monitored and recorded on a log form at 15-min intervals by MRI personnel. Process data collected include the list presented in Table 3-1.

3.3 SUMMARY OF SAMPLING AND ANALYSIS PROCEDURES

This section provides a brief description of the test program. Testing activities were separated into two parts, metals/particulate and organics, since there were insufficient sampling ports at the facility to conduct all sampling at one time. Tables 3-2 and 3-3 summarize the measurements for each portion of the test.

3.3.1 Summary of Metals/Particulate Sampling and Analysis Activities

Table 3-2 presents a summary of the sampling and analysis parameters and methods for the metals/particulate series of tests. This table identifies the location, frequency, method, and size for each sample taken, along with the preparation and analytical methods to measure the analytes. Samples were taken for metals (As, Cd, Cr, Pb) analyses from the liquid organic waste feed stream, the aqueous waste feed stream, the scrubber makeup water, and the scrubber effluent water. Stack gas samples were collected to measure the metals emissions (including hexavalent chromium), particle size distribution, particulate matter emissions, and oxygen and carbon dioxide levels. Thus all feed streams, effluents, and emission sources were sampled to supply necessary information for a mass balance. The metals and particle size samples were collected concurrently, followed immediately by collection of the particulate samples. Full descriptions of sampling activities are contained in Appendix A-1.

TABLE 3-1. PROCESS PARAMETERS MONITORED DURING TESTING

Incinerator	
Firing rate	Btu/h
Combustion chamber temperature	°F
Aqueous waste feed rate	gpm
Organic waste feed rate	gpm
Auxiliary fuel feed rate (natural gas, fuel oil)	Btu/h
Combustion air feed rate	acfm
Oxygen content of flue gas	%
CO level of flue gas	ppm
Tempering water flow rate	gpm
Spiked metals (As, Cr, Cd, Pb) feed rate*	g/min
Quench	
Quench water flow rate	gpm
Outlet gas temperature	°F
Venturi Scrubber	
Pressure drop across venturi	in water
Inlet water feed rate	gpm
Packed-Bed Scrubber	
Scrubber effluent pH	pH
Scrubber effluent flow rate	gpm

* Tests 1 through 4 only.

TABLE 3-2. SUMMARY OF SAMPLING AND ANALYSIS PARAMETERS AND METHODS FOR METALS AND PARTICULATE

Sample	Sample location[a]	Sampling frequency for each run	Sampling method	Sample size	Test series[b]	Target analytical parameters	Preparation method	Analytical methods[c,d]
Organic liquid waste	S1	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 150 mL per grab)	A, B	As, Cd, Cr, Pb	Dissolution (SW-846-3040)	ICP (SW-846-6010)
	S1	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 150 mL per grab)	A, B	Ash	N/A	Ignition (ASTM D482-80)
Aqueous waste	S2	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 150 mL per grab)	A, B	As, Cd, Cr, Pb	Acid digestion (SW-846-3050)	ICP (SW-846-6010); GFAAS (SW-846-7000 series) as needed
	S2	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 150 mL per grab)	A, B	Ash	N/A	Ignition (ASTM D482-80)
Makeup water (city)	S3	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 500 mL per grab)	A	As, Cd, Cr, Pb	Acid digestion (SW-846-3050)	ICP (SW-846-6010); GFAAS (SW-846-7000 series) as needed
Recycle water	S4	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 500 mL per grab)	A, B	As, Cd, Cr, Pb	Acid digestion (SW-835-3050)	ICP (SW-846-6010); GFAAS (SW-846-7000 series) as needed
Effluent water	S5, S6	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 500 mL per grab)	A, B	As, Cd, Cr, Pb	Acid digestion (SW-846-3050)	ICP (SW-846-6010); GFAAS (SW-846-7000 series) as needed
	S5, S6	One grab sample every 30 min composited into one sample	Tap (S004)	1 L (~ 500 mL per grab)	B	Cr (hexavalent)	Coprecipitation (SW-846-7195), then acid digestion (SW-846-3050)	ICP (SW-846-6010); GFAAS (SW-846-7191) as needed
Combustion gas	S7	Continuous 3 h	MM5-M[e]	2-3 m^3 (dry)	A, B	As, Cd, Cr, Pb	HF/HNO_3 digestion in microwave PRVs (EMB Draft Method) of particulate; acid digestion (SW-846-3050) of impinger solution	ICP (SW-846-6010); GFAAS (SW-846-7000 series) as needed

(continued)

TABLE 3-2 (continued)

Sample	Sample location[a]	Sampling frequency for each run	Sampling method	Sample size	Test series[b]	Target analytical parameters	Preparation method	Analytical methods[c,d]
Combustion gas (continued)	S7	Continuous 3 h	MM5-Cr6[f]	2-3 m^3 (dry)	B	Cr (hexavalent)	Alkaline digestion (EPA Draft Method); coprecipitation (SW-846-7195) of impinger solution	ICP (SW-846-6010); GFAAS (SW-846-7191) as needed
	S7	Continuous ~ 60-120 min	MM5-M[g] cyclones/ impactor	TBD[h]	A, B	As, Cd, Cr, Pb by particle size distribution	HF/HNO_3 digestion in microwave PRVs (EPA Draft Method)	ICP (SW-846-6010); GFAAS (SW-846-7000 series) as needed
	S7	Continuous 3 h	M3	~ 50 L (dry)	A, B	CO_2, O_2	N/A	Orsat
	S7	Continuous 2 h	M5	1-2 m^3 (dry)	C	Particulate	Desiccation	Gravimetric (EPA M5)
	S7	Continuous 2 h	M3	~ 50 L (dry)	C	CO_2, O_2	N/A	Orsat

Note: Sampling method numbers (e.g., S004) refer to methods published in "Sampling and Analysis Methods for Hazardous Waste Combustion," EPA-600/8-84-002; sampling methods beginning with prefix M refer to USEPA methods published in the Code of Federal Regulations, Title 40, Part 60, Appendix A; analytical methods beginning with SW-846 refer to methods published in USEPA Manual SW-846, third edition.

N/A = Not applicable.

[a] Refers to sampling locations depicted in Figure 2-1.

[b] A = Baseline test (1 run with no spiking); B = metals removal efficiency test (3 runs with metals spiking of aqueous waste); C = particulate test (4 runs one immediately following each A run and B run).

[c] ICP = inductively coupled plasma emission spectroscopy; GFAAS = graphite furnace atomic adsorption spectroscopy.

[d] If an analytical result is less than 5 times the detection limit by Method 6010 for any analyte, that analyte will be analyzed by the appropriate series 7000 method of SW-846 for that analyte using GFAAS.

[e] MM5-M = Modified Method 5 train used to collect metals (As, Cd, Cr, Pb)--impinger solutions and recovery reagents modified.

[f] MM5-Cr6 = Modified Method 5 train used to collect hexavalent chromium--impinger solutions and recovery reagents modified.

[g] MM17 = Modified Method 17 train (in-stack filtration) used to collect particulate matter by particle size distribution (e.g., > 10, 5-10, 1-5, < 1 um size).

[h] Sample volume and sampling time to be determined from particulate loading of the gas.

TABLE 3-3. SUMMARY OF SAMPLING AND ANALYSIS PARAMETERS AND METHODS FOR ORGANICS[a]

Sample	Sample location[b]	Sampling frequency for each run	Sampling method	Sample size	Target analytical parameters	Preparation method	Analytical methods[c]
Combustion gas	S7	Continuous 3-h	M3	~ 50 L (dry)	CO_2, O_2	N/A	Orsat
	S7	Continuous 3-h	MM5[d]	2-3 m^3 (dry)	Organics: (C_7-C_{17})	CH_2Cl_2 + ether + toluene extractions[e]	GC/FID, DB-1 column
					(> C_{17})	CH_2Cl_2 + ether + toluene extractions[e]	Gravimetric
	S7	Continuous 3-h	Integrated gas sample (Tedlar bag plus condensate)	10-15 L (dry)	Organics: (C_1-C_7) C_1 and C_2	N/A	GC/FID: DB-1 column GS-Q column
				Condensate volume	(C_1-C_7), C_1 and C_2	N/A	GC/FID, GS-Q column
	S7	Continuous 3-h	MM6[f] (DNPH)	90 L (dry)	Formaldehyde	N/A	HPLC/UV (A-132)
	S7	Continuous 3-h	M25A	N/A	THC	Heated sample lines and analyzer	FID
	S7	Continuous 3-h	M25A	N/A	THC	Unheated lines	FID
	S7	Continuous 3-h	Plant's CEMS[g]	N/A	CO	Gas conditioning	NDIR analyzer

Note: Sampling method numbers (e.g., A-132) refer to methods published in "Sampling and Analysis Methods for Hazardous Waste Combustion," EPA-600/8-84-002; sampling methods beginning with prefix M refer to USEPA methods published in the Code of Federal Regulations, Title 40, Part 60, Appendix A.

N/A = Not applicable.

[a] Organic measurement method comparison test for 6 runs at varying CO levels.

[b] Refers to sampling locations depicted in Figure 2-1.

[c] GC/FID = Gas chromatography/flame ionization detector; HPLC = high performance liquid chromatography.

[d] MM5 = Modified Method 5 train used to collect semivolatile organic compounds--XAD trap and modified recovery reagents.

[e] Ether = methyl *t*-butyl ether. Extraction required is methylene chloride, ether, and toluene. Each extract is analyzed separately.

[f] MM6 = Modified Method 6 train used to collect formaldehyde--all fritted bubblers, modified impinger solutions (2,4-dinitrophenylhydrazine), and recovery reagents.

[g] Calibration check will be performed with certified calibration gases.

A baseline run (Run 1) was conducted to determine the background level of metals (As, Cd, Cr, Pb) in (a) the organic and aqueous waste feed streams, (b) the scrubber influent (makeup water) and scrubber effluent water streams, (c) the stack emissions, and (d) the particle size fractions. Chromium compounds are used in the incinerator refractory; therefore, it was necessary to document the background levels. No measurements for hexavalent chromium were performed during the baseline run.

The particle size train was operated during the baseline run for two reasons: (1) to identify any problems with collecting adequate samples in each size fraction, and (2) to evaluate background chromium levels that might be present because of the refractory and stainless steel parts in the train.

Particle size samples were extracted through a heated borosilicate glass probe liner (nominally maintained at 10°F above the stack temperature) and a nickel nozzle. Quartz nozzles could not be used since the available nozzles were too large for isokinetic sampling at the desired rates. The best available choice was nickel nozzles of 0.375 in inside diameter, which allowed isokinetic sampling rates of 25% to 28%. During Run 2 particle size sampling, problems were encountered with maintaining gas exit temperature above the dew point. Recovery indicated that the final filter was saturated with moisture, invalidating the results for the run. Run 3 was aborted because of overheating of the sampler following a thermocouple problem. Run 4 was performed successfully, and ambient air was pulled through the system to purge the moist stack gas remaining in the sampler while temperature was maintained above the dew point. Run 4 and the baseline run provided the only usable data from the test series.

No significant problems occurred with the MM5-M metals sampling of the stack emissions. All four tests fell within the acceptable range for isokinetic performance, and all leak checks were passed. Method 3 (Orsat) sampling for CO_2 and O_2 was performed concurrently with particulate and metals sampling, with an unheated, stainless steel probe attached to the probe sheath of the appropriate train.

3.3.2 Summary of Sampling and Analysis for Organics

Total organic emissions were measured both by THC stack concentration and the total Level 1 organic analysis matrix. Compounds specifically identified by GC/FID were methane, ethane, ethylene, and acetylene. Formaldehyde was quantified using a special (DNPH) train and HPLC, since that compound has no FID response. All other organics were reported by broad retention index (RI) totals (e.g., RI 200-299) or as total mass. Full descriptions of the sampling and analysis activities are contained in Appendix A.

Combustion gas was sampled in the stack for a period of 3 h. Several sampling methods were required to obtain total emission data for the C_1 and C_2, C_1-C_7, and C_7-C_{17} organic compounds, formaldehyde, and total hydrocarbons. These methods are listed in Table 3-3 and are summarized below. A pre-evacuated Tedlar bag was used to collect stack gas for the C_1-C_7 organic compounds. Condensate in the sampling system was impinged in a cold trap and analyzed. The C_7-C_{17} organic compounds were collected in a Modified Method 5 (MM5) sampling train. Formaldehyde was impinged in a 2,4-dinitrophenylhydrazine (DNPH) solution using a Modified Method 6 (MM6) sampling train. THC was measured using both heated and unheated sampling lines and a continuous FID detector.

One problem encountered during the test series was a broken XAD temperature thermowell in the XAD exit U-tube of the MM5 train. This resulted in the Run 6 isokinetic to be slightly out of the 100% ± 10% range (see data in Appendix B-4). Examination of moisture data and the air leakage rate supports the belief that significant ambient air did not enter the sample; EPA personnel agreed to use the data from the run.

The target analytical parameters listed in Table 3-3 were analyzed by several methods. The volatile organic compounds (C_1-C_7) were analyzed by GC/FID using the method referenced in EPA-600/7-78-201. The suggested Porapak Q column was replaced with a 30-m GS-Q megabore column to obtain resolution of methane, ethane, ethylene, and acetylene. This column was also used to analyze volatile organic compounds impinged in the condensate trap. The suggested OV-101 column was replaced with a 30-m DB-1, 5-μ megabore column to obtain resolution of the C_1-C_7 paraffins.

The semivolatile organic compounds (C_7-C_{17}) were extracted according to the procedure given in "POHCs and PICs Screening Protocol," Southern Research Institute, Draft Report, February 10, 1988, Section III-C with the following changes: all sample components were extracted with methylene chloride, methyl t-butyl ether, and a third time with toluene. The analysis of these compounds was by GC/FID using a 30-m, DB-1, 1-μ megabore column. The condensate was also extracted with each of the three solvents and analyzed as separate sample fractions.

Formaldehyde was extracted with chloroform and analyzed according to the method referenced in EPA-600/8-84-002 which uses high performance liquid chromatography (HPLC).

Total hydrocarbons were analyzed by EPA Method 25A for both heated and unheated sampling lines with the following minor changes. The entire system from probe to detector was heated to 150°C for the heated sample line approach. For the unheated sample line approach, an ice-cooled water knockout trap was used to remove condensables, and an unheated Teflon line conducted the sample through a stainless steel pump to an FID.

3.3.3 Blanks

To give the best possible measure of organic levels, extra effort was given to obtaining blank levels for each method. Prior to testing, the following analyses were performed:

1. Ascertain low DNPH blanks for formaldehyde analysis. DNPH itself was not available in high purity, and the solvents used have trace contamination which causes blank results of between 0.1 and 1 μg/L. The normal purification procedure was improved by extraction of the DNPH with methylene chloride instead of chloroform. The final check was a full-proof rinse of the complete sampling train and analysis of the recovered sample.

2. Test blank levels for gravimetry and GC/FID. The XAD cleanup specification in SW-846 suggests a TCO (C7-17) blank of 4 mg/kg resin which would be equivalent to 0.1 μg/L of stack gas. No data were available for the other

two extraction solvents. After verifying reagent purities, full-proof rinses of two sample trains were analyzed in addition to a reagent method blank.

3. Optimize GC/FID for high sensitivity and low background. The GC needs to operate near maximum sensitivity, requiring very clean gas supplies and special care to prevent contamination. Bonded phase Megabore columns were used to prevent column bleed from limiting sensitivity. The GC was operated at MRI instead of on site but used exactly the same components as if it were at a field site. Blank bag samples were taken in conjunction with each volatile organic bag sample.

3.4 DATA REDUCTION/INTERPRETATION

3.4.1 CEM Data Reduction

The CEM raw data were first converted from percent of full-scale values to percent (O_2 and CO_2) or ppm (CO and THC) values using a data logging program. This conversion was based upon the average of initial and final zero and span calibration data.

Beginning with Run 8, adjustments were made to both the heated THC and unheated THC scales mid-run to reduce excessive drifts. These instruments were rezeroed and spanned at hourly intervals during Runs 8, 9, and 10. Subsequently, calibration data for these runs were broken into four parts: A, B, C, and D. Each part has separate drift calculations. Appendix B-1 contains the summary of CEM calibration data. A 3% drift is considered acceptable by EPA Method 6C for continuous monitoring. Drift percent values are based on the average span for the run and may be slightly different from the raw data printouts, which are erroneously based on the initial span only.

After each test, the CEM response delay time was measured by removing the probe from the stack and sampling ambient air. Response delay time was calculated from the time taken for each individual monitor to attain 95% of the ambient value. Appendix B-1 presents the results. Readings for each monitor were adjusted by the appropriate response delay time for each run to ensure correctness of the data over the time interval specified.

3.4.2 Volatile and Semivolatile Organics Data Reduction

3.4.2.1 Volatile Organics--

Areas integrated under each peak were summed to give a total peak area for each run. This value was then divided by the average daily reference factor for propane, resulting in a total organics concentration for ppm propane equivalent. The average daily reference factor was obtained from an average of peak areas for a standard propane sample of known concentration. For low molecular weight hydrocarbons (C_1-C_2), retention times for individual peaks could be compared to other standards to allow a breakdown of the total to separate species (methane, ethane, acetylene, etc.). An example calculation is shown below.

	Retention time	Peak area	
Run 6	60	20,213	Avg. RF for propane = 3,885
	102	48	
	111	1,304	
	Total	21,564	

Total concentration = 21,564/3,885 = 5.55 as ppm propane

Retention time = 60 (methane) = 20,213/3,885 = 5.20 as ppm propane
102 (ethylene) = 48/3,885 = 0.01 as ppm propane
111 (ethane) = 1,304/3,885 = 0.34 as ppm propane

3.4.2.2 Semivolatile Organics--

As with the volatile organics, areas under each peak for the semivolatile organics were integrated and summed to give a total value. C_{12} was used as a reference standard and a comparison of sample area to standard area allows a quantitation of the sample to be made. Due to the numerous possibilities for different chemical species present, further quantitation of individual compounds was not feasible.

3.4.3 Blank Corrections

3.4.3.1 MM5 Metals Data--

MM5 data for the metals train was blank-corrected by the train proof blank samples. Reagent blank corrections were not performed. The blank correction procedure used is described below. All blank values are shown in Appendix B-3.

Front and back halves of the train were blank-corrected separately. The blank correction procedure usually involved a simple subtraction of the proof blank value from the appropriate train sample. For those cases where blank values and sample values were quite similar, however, the following criterion was set:

- If sample value ≤ 2X blank value, the results are given as a possible data range minimum and maximum (blank-corrected and not blank-corrected).

- If sample value > 2X blank value, the blank value is subtracted and results are given as a single quantity.

An example calculation for the blank correction is shown below.

	Quantity (μg)
Sample	
Front half	16.2
Back half	17.5
Total	33.7
Blank	
Front half	15.0
Back half	1.65
Total	16.6

Front half: Is 16.2 < (2 x 15.0) ... yes, then

min. = 16.2-15.0 = 1.2
max. = 16.2-0 (no correction) = 16.2

Back half: Is 17.5 < (2 x 1.65) ... no, then

Back half = 17.5-1.65 = 15.85

Total = front half + back half

min. = 1.2 + 15.85 = 17.10 μg
max. = 16.2 + 15.85 = 32.07 μg

3.4.3.2 Volatile Organics--

All C_1-C_2 and C_3-C_7 sample data were blank-corrected by the median blank bag value for the test series. The median blank value in ppm propane was determined and subtracted from the sample values for each run. Any negative results were reported as "zero." Table 3-4 summarizes the blank data. No blanks were applicable to the condensate samples.

Individual C_1-C_2 compounds were blank-corrected by their respective blank values. Individual blank values for C_1-C_2 compounds were calculated identically to that of the total C_1-C_2 fraction. The median value for the test series was chosen in all cases. Table 3-5 displays the blanks for each C_1-C_2 compound.

TABLE 3-4. C_1-C_7 BLANKS

Run	C_1-C_2 blank (ppm propane)	C_3-C_7 blank (ppm propane)
5	0.62	0.15
6	5.57	0.34
7	7.33	0.35
8	7.07	0.37
8S	8.03	0.34
9	6.16	0.40
10	3.22	1.90

Note: C_1-C_2 median value used as blank = 6.16 μg
C_3-C_7 median value used as blank = 0.35 μg

TABLE 3-5. C_1-C_2 BLANK CORRECTIONS

Compound	Run no.							Blank value[a]
	5	6	7	8	8S	9	10	
(as ppm propane)								
Methane	0.54	5.20	6.83	6.65	7.60	5.75	2.63	5.75
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00	0.16	0.00
Ethylene	0.00	0.00	0.00	0.00	0.00	0.00	0.15	0.00
Ethane	0.08	0.37	0.51	0.43	0.44	0.41	0.28	0.41
(as ppm methane)								
Methane	1.75	16.86	22.15	21.56	24.64	18.67	8.52	18.67
(as ppm acetylene)								
Acetylene	0.00	0.00	0.00	0.00	0.00	0.00	0.23	0.00
(as ppm ethylene)								
Ethylene	0.00	0.00	0.00	0.00	0.00	0.00	0.26	0.00
(as ppm ethane)								
Ethane	0.12	0.54	0.73	0.62	0.64	0.59	0.40	0.59

[a] Median value for the test series.

3.4.3.3 Semivolatiles and Nonvolatiles--

Two blank trains (Runs 6 and 7) and a method blank were analyzed and the results used in determining blank corrections. For each sample component (train and condensate) there were three extractions performed (methylene chloride, ether, and toluene) making for a total of six blank corrections to be calculated. In each of these six cases, the median value of the two blank trains and the method blank was chosen as the blank correction value, which was subtracted from the sample value. Blank correction for the nonvolatiles used the same procedure. Tables 3-6 and 3-7 contain the blank values calculated for each sample fraction.

In some cases, large blanks have caused blank-corrected values of semivolatile and nonvolatile organic compounds to be negative. Note that these negative quantities have been treated as such and have not been set to zero unless the final sum of all extract fractions is still negative. This procedure was followed to account for the natural scatter of the various blank values. To have zeroed those fractions which were negative due to high blank values would have resulted in a high bias in the scatter of blank-corrected quantities.

3.4.3.4 Formaldehyde--

The DNPH reagent blank and blank train values shown below were used in determination of a blank value.

DNPH reagent blank = 3.68 µg
Blank train = 6.38 µg

The blank train value was used because it represented a larger portion of the sampling and analytical technique. This value was subtracted from the sample values to calculate the blank-corrected values.

TABLE 3-6. SEMIVOLATILE BLANKS

	Blank type	Quantity (μg)	Blank value (μg)[a]
Train fractions			
$MeCl_2$	Run 6 proof	324.3	324.3
	Run 7 proof	460.6	
	Method blank	291.4	
Ether	Run 6 proof	331.5	331.5
	Run 7 proof	204.5	
	Method blank	587.2	
Toluene	Run 6 proof	1236.0	1745.4
	Run 7 proof	1745.4	
	Method blank	2355.5	
Total train blank			2401.2
Condensate fractions			
$MeCl_2$	Run 6 proof	308.4	215.1
	Run 7 proof	215.1	
	Method blank	185.2	
Ether	Run 6 proof	480.5	480.5
	Run 7 proof	741.5	
	Method blank	452.0	
Toluene	Run 6 proof	788.8	648.4
	Run 7 proof	648.4	
	Method blank	495.1	
Total condensate blank			1344.0
Blank total			3745.2

[a] Median value of two proof blank trains and method blank.

TABLE 3-7. NONVOLATILE BLANKS

	Blank type	Quantity (g/mL)	Blank value (g/mL)[a]
Train fractions			
$MeCl_2$	Run 6 proof	0.00088	0.00018
	Run 7 proof	0.00018	
	Method blank	0.00015	
Ether	Run 6 proof	0.00018	0.00018
	Run 7 proof	0.00025	
	Method blank	0.00007	
Toluene	Run 6 proof	0.00010	0.00007
	Run 7 proof	0.00007	
	Method blank	0.00007	
Total train blank			0.00043
Condensate fractions			
$MeCl_2$	Run 6 proof	0.00002	0.00002
	Run 7 proof	0.00002	
	Method blank	-0.00005	
Ether	Run 6 proof	0.00006	0.00006
	Run 7 proof	0.00011	
	Method blank	0.00005	
Toluene	Run 6 proof	0.00001	0.00001
	Run 7 proof	0.00001	
	Method blank	0.00006	
Total condensate blank			0.00009
Blank total			0.00052

[a] Median value of two proof blank trains and method blank.

SECTION 4.0

DISCUSSION OF RESULTS

This section presents the data obtained from the test and analyzes the data relative to the project objectives. The section is divided into four subsections. The first discusses process data and operation of the incinerator. The following three sections present the results of the particulate and particle size, metals, and organics measurements, respectively.

4.1 PROCESS DATA

This subsection provides a summary and evaluation of the process operating parameters under which the incinerator operated during the metals/particulate testing and the organics testing. Because the overall objectives of each of these portions of the test were different, the process operating parameters of interest differed. The process data for each portion of the test is presented and discussed separately below.

4.1.1 Metals/Particulate Tests

The primary objective of the metals/particulate test runs (Runs 1-4), with respect to the operation of the incinerator, was to maintain similar operating conditions for each of the test runs. Consistency between the runs is very important, particularly with respect to the waste feed rates, combustion chamber temperature, and pressure drop across the venturi scrubber. A summary of the process data for several parameters for each of the four runs is presented in Table 4-1. The initial run was performed without the addition of metals to the waste feeds in order to obtain background data to help evaluate the results of the subsequent three runs. An average stack gas carbon

TABLE 4-1. PROCESS DATA--AVERAGES FOR RUNS 1 THROUGH 4

Test run	Heat input, x 10^{-6} (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas oxygen level, wet[a] (%)	Flue gas CO level (ppm)	Combustion air flow rate (acfm)	Auxiliary fuel		Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Scrubber water feed rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in H_2O)	Scrubber recycle flow rate (gpm)	Scrubber alkali feed rate (gpm)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
							Natural gas (acfm)	Fuel oil (gpm)											
1	26.0	952	90	3.1	35	6,000	2,600	0	3.0	6.4	na	47	60	198	50	540	1.3	92	7
2	28.8	950	91	1.4	33	6,000	3,270	0	3.3	6.8	2.0	46	43	196	51	530	2.0	69	7
3	31.9	954	91	2.3	33	6,100	5,770	0	3.0	6.4	1.9	48	43	196	51	540	1.8	90	7
4	29.0	954	91	1.9	31	6,030	5,910	0	3.0	6.0	2.0	48	58	195	49	535	1.8	88	7
Avg.	28.9	953	91	2.2	33	6,030	4,390	0	3.1	6.4	2.0	47	51	196	50	536	1.7	85	7

[a] Conversion for wet to dry basis: $\%O_2$ (dry) = $\%O_2$ (wet)/(1-$\%H_2O$); % H_2O was about 60.

monoxide (CO) level of 33 ppm was maintained during the four runs. This range is indicative of good combustion conditions within the combustion chamber.

As shown in the table, the principal process operating parameters were relatively consistent during the four runs. The average organic waste feed rate ranged between 3 and 3.3 gal/min and the average aqueous waste feed rate ranged from a rate of 6.0 to 6.8 gal/min. The average combustion chamber temperature was maintained over a close range of 950° to 954°C. During routine operations, the combustion chamber temperature is maintained between 950° and 1000°C.

The plan for these four runs was to maintain the pressure drop across the venturi scrubber at a level of 50 in. During the four runs, the average pressure drop ranged from 49 to 51 in, which was quite consistent. A pressure drop of 50 in was maintained specifically for these four tests and is somewhat greater than the pressure drop employed during normal incinerator operation (40-50 in).

A tabulation of the values for each process parameter recorded about every 15 min during each of the four runs is presented in Appendix B-6.

4.1.2 Organic Tests

The primary objective with respect to the operation of the incinerator during Runs 5 through 10 was to increase the level of CO in the combustion gas across the six runs to attain levels from 100 to 5,000 ppm CO, as discussed in Section 3.3.3.2. The attainment of these levels was to be accomplished by modifying various operational parameters during each of the runs. During the conduct of the runs at the higher CO levels, it was determined that the attainment of the planned 3,700 and 5,000 ppm levels at 7% O_2 was not possible. This is discussed further in Section 4.1.2.2.

A summary of the average values of several key operational parameters for each of the six runs plus one supplemental run is presented in Table 4-2. The following discussion of these data are divided into three sections. First, a brief discussion will be presented for those runs (5, 6, 7, 8S, and 10) that

TABLE 4-2. PROCESS DATA--AVERAGES FOR RUNS 5 THROUGH 10

Test run	CO uncorrected (ppm)	CO @ 7% O_2 (ppm)	Hot THC, dry (ppm)	Cold THC, dry (ppm)	O_2, dry (%)	Heat input, $\times 10^{-6}$ (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel		Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in H_2O)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
											Natural gas (acfh)	Fuel oil (gpm)								
	MRI data					Mobay process data														
5	125	111	36.4	3.6	5.3	35.2	865	92	55	7,200	0	0.5	5.0	13.9	0	48	227	45	68	7.1
6	511	460	88	12	5.4	33.2	793	91	443	7,161	4,257	0	4.5	10.7	0	48	222	43	76	7.1
7	1,099	1,068	207	7.6	6.6	33.7	802	91	1,693	7,325	0	0	5.6	12.3	2.2	47	214	40	86	7.1
8	2,460	2,464	227	61	7.1	34.1	765	91	3,815	7,250	0	0	5.7	14.4	5.0	47	212	39	88	7.1
8S	196	168	51.2	6.7	4.7	34.5	829	91	73	7,100	4,129	0	4.9	13.4	3.5	47	222	46	81	7.1
9	3,705	2,762	199	61	2.2	41.3	820	93	4,536	6,850	0	0	5.0	13.4	7.6	48	225	43	74	7.1
10	2,458	2,128	85.6	18	4.8	35.7	800	91	3,000	7,000	0	0	6.2	12.0	7.8	47	225	43	90	7.1

achieved the desired CO levels with operation of the incinerator at or close to normal. A comparison and discussion of the three runs (8, 9, and 10) at CO levels between 2,000 and 2,500 ppm is presented next, followed by a discussion of CO generation.

4.1.2.1 Operation at Low CO Levels--

Run 5 was designed to achieve CO and THC levels that represented relatively normal incinerator operating conditions of 50 to 100 ppm CO in the combustion gas. During the run fuel oil was employed as an auxiliary fuel. An average stack gas CO level of approximately 100 ppm (at 7% O_2) was achieved, but a lower combustion chamber temperature of 865°C was required.

In Run 6, an average CO level of 460 ppm was obtained. During the initial stages of this run, it was determined that the use of fuel oil as the auxiliary fuel presented difficulties in maintaining relatively constant CO levels during the run. Therefore, the auxiliary fuel was changed to natural gas and the control of the CO level was much improved. Using natural gas as the auxiliary fuel and decreasing the combustion chamber temperature to about 800° to 820°C resulted in attainment of elevated CO levels and better control of the CO levels during the run.

Run 8S (Run 8, supplemental) was performed to achieve average stack gas CO levels close to those in Run 5 using natural gas as the auxiliary fuel. The purpose was to compare organic emission levels between the two runs when using different auxiliary fuels. For Run 8S, the operating parameters were relatively close to those in Run 5, except for combustion chamber temperature. The combustion chamber temperature was 829°C in Run 8S as compared to 865°C in Run 5 using fuel oil as the auxiliary fuel.

Runs 7 and 10 achieved average stack gas CO levels of approximately 1,050 ppm and 2,125 ppm, respectively, with average operating parameters similar to those used in Run 6. However, in both of these runs, it was necessary to inject tempering water into the combustion chamber to elevate the levels of CO. The generation of CO as a function of total water input to the combustion chamber will be discussed in Section 4.1.2.3. In Run 7, it was necessary to add an average flow rate of 2.2 gal/min of tempering water and for Run 10, an average flow rate of 7.8 gal/min was required.

4.1.2.2 Operation at High CO Levels--

In the planned experimental design, the attainment of the higher CO levels (3,700 and 5,000 ppm) was based on information relative to the facility CO monitor used during the normal operation of the incinerator, but the levels recorded by this monitor are not corrected to 7% oxygen. During the performance of tests at lower CO levels, an inconsistency was observed between the levels recorded by the plant CO monitor and the CO monitor used by MRI. This inconsistency may be a result of the different physical locations of the monitors or the different calibration procedures. MRI's CO monitor was rechecked and is believed to be correct.

In Runs 8 and 9, the average CO levels recorded by the plant monitor were approximately 3,800 and 4,500 ppm, respectively, However, the levels recorded by MRI and corrected to 7% O_2 showed the CO levels to be about 2,460 and 2,760 ppm, respectively. Attempts to increase the CO levels to the proposed levels of 3,700 and 5,000 ppm (at 7% O_2) and maintain there steady were unsuccessful. In Run 8, the elevated average CO level was obtained by maintaining the average % oxygen levels at approximately the same levels as the previous runs and decreasing the combustion chamber temperature to an average of 765°C. For Run 9, the combustion chamber temperature was maintained at an average of 820°C and the flow of tempering water and aqueous waste feed was increased resulting in a low average % oxygen level. In Run 10, the average combustion chamber temperature was 800°C and the average % oxygen level was similar to levels observed in the previous runs at lower CO levels. For this run, the organic waste feed rate was increased about 20% over Run 9 while maintaining about the same aqueous waste feed rate and flow of tempering water as in Run 9. An average stack gas CO level of 2,130 ppm was observed for Run 10.

An overall comparison of the average operating process parameters for Runs 8, 9, and 10 show the following:

- Run 8--low combustion chamber temperature (765°C), relatively normal % oxygen level, stack gas CO level of ~ 2,460 ppm

- Run 9--combustion chamber temperature of 820°C, very low % oxygen level, stack gas CO level of ~ 2,760 ppm

- Run 10--combustion chamber temperature of 800°C, relatively normal % oxygen level, stack gas CO level of ~ 2,130 ppm

4.1.2.3 Carbon Monoxide Generation--

In the attempts to generate elevated levels of stack gas CO during the last three runs of these tests, one of the operating parameters that was effectively varied was the total water input to the combustion chamber. For this incinerator, there are multiple injection nozzles in the combustion chamber for the introduction of aqueous waste feeds and city water, which is used to temper the temperature in the chamber. All of these nozzles are at the same level in the vertical combustion chamber so that the total water input occurs at the same level.

The elevation of the stack gas CO concentrations in relation to high total water input into the combustion chamber may be a direct result of the cooling of the combustion temperature in the flame and resultant decrease in the rate of oxidation of CO. Figure 4-1 compares the levels of CO in the stack gas as a function of total water input into the combustion chamber. In this comparison, total water input is defined as the total of the aqueous waste feed and the tempering water flow rate. The results show that, over the range studied, there appears to be a relationship between the two parameters.

4.2 PARTICULATE EMISSIONS AND SIZE DISTRIBUTION

Particulate loading in the stack gas was determined during the same test runs that involved metals sampling (Runs 1 to 4). The weight gain on the filter of the multiple metals sampling train was added to the weight remaining after evaporation of the acetone probe rinse to determine the particulate

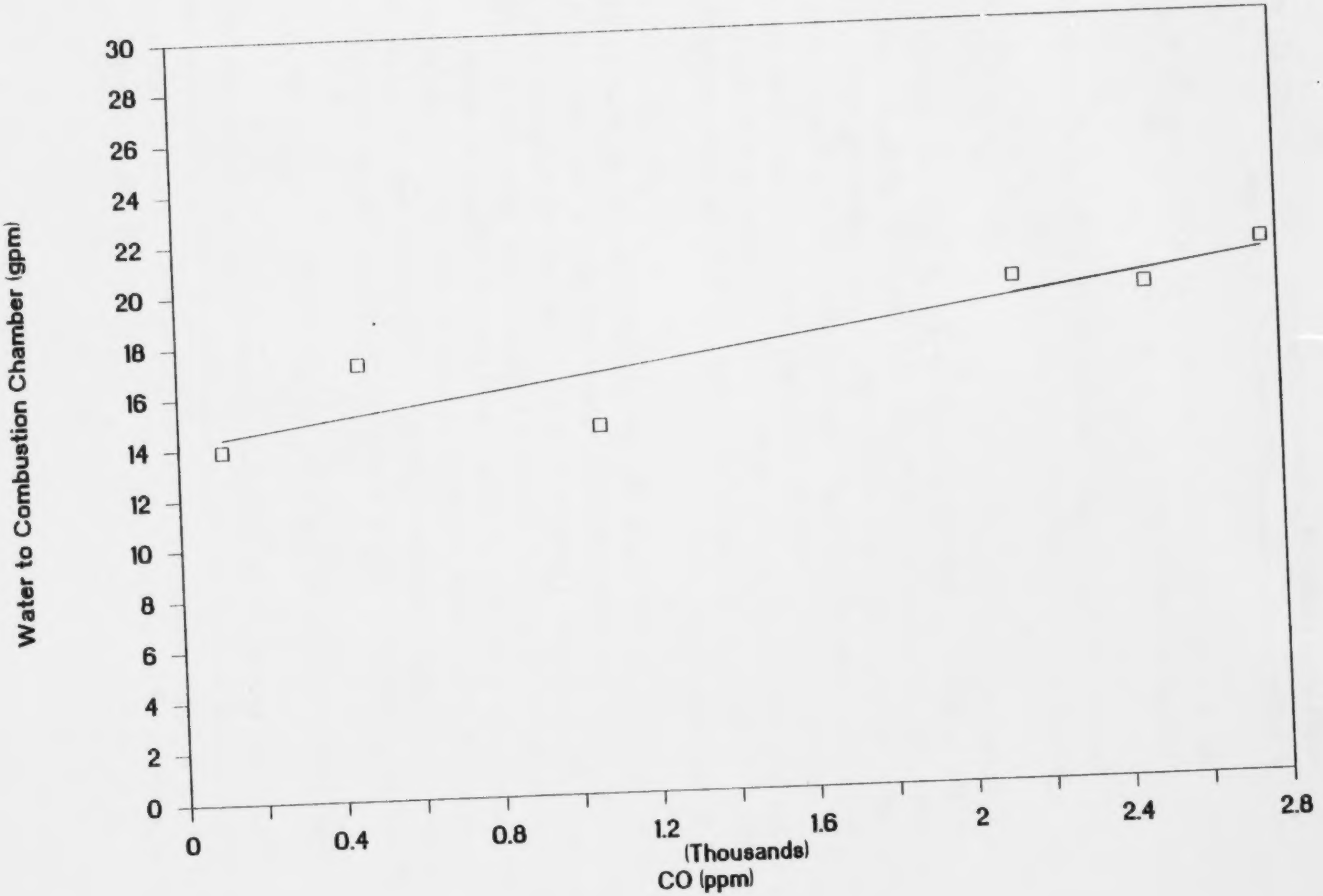

Figure 4-1. CO vs. total water input.

weight. Table 4-3 presents the particulate weights and calculated particulate loading and emission rates for these runs. Complete data are provided in Appendix B-2.

The particulate loading for each run was approximately 0.02 gr/dscf, well below the hazardous waste incinerator performance standard of 0.08 gr/dscf. These low results are typical of incinerator pollution control systems involving a high energy venturi scrubber. The emission rates are all between 1 and 2 lb/hr. The emission rate for the baseline run (Run 1) was lower than for any of the other three runs when metals were spiked. This is expected due to the higher ash input to the combustor from the spiked metals in the latter three runs.

Control device particulate removal efficiency was estimated from the ash inputs to the combustor and stack particulate emissions. Table 4-4 presents the results of this estimate. Ash input is calculated from the waste feed rate, % ash, and specific gravity of the waste. The comparison showed greater than 98% ash removal through the process. Actual ash removal efficiencies may be greater than the table indicates, as the carry-over of salt particles from the scrubber may have increased the stack particulate loading.

The distribution of particulate matter by particle size was also determined for Runs 1 and 4 by using an Andersen high capacity source sampler (HCSS). The particle size train was also operated during Runs 2 and 3, but the samples were invalidated as explained in Section 3.3. The particle size results are summarized in Table 4-5. The net collected weight for each stage of the sampler is shown, along with the percent of total and the cumulative percent collected at each stage of the sampler. In addition, two methods of expressing the size of particles collected by each stage (the D_{50} size and the geometric mean diameter) are defined and used in Table 4-5.

Over 80% of the total particulate matter was collected in the submicron range. This is expected following the high energy venturi scrubber. It is likely that the venturi was successful in removing particles larger than 1-μ size so that the remaining particulate matter mainly consisted of submicron particles.

TABLE 4-3. PARTICULATE LOADING RESULTS FROM MULTIPLE METALS SAMPLING TRAIN

Run	Particulate wt. (g)[a]	Sample gas volume (dscf)	Particulate loading (gr/dscf) corrected to 7% O_2	Emission rate (lb/h)
1	0.0942	78.647	0.0196	1.12
2	0.1359	78.299	0.0223	1.62
3	0.1084	77.126	0.0199	1.29
4	0.1206	77.810	0.0212	1.43

[a] Particulate weight is the net weight of the probe rinse plus the net weight of the filter determined by EPA Method 5.

TABLE 4-4. CONTROL DEVICE PARTICULATE REMOVAL EFFICIENCY

Run	Organic waste[a] Ash, %	Organic waste[a] Flow (gpm)	Aqueous waste[b] Ash, %	Aqueous waste[b] Flow (gpm)	Ash input rate (lb/h)	Particulate emissions (lb/h)	% Removal
1	0.136	3.0	2.96	6.4	101	1.12	98.9
2	0.045	3.3	3.07	6.8	109	1.62	98.5
3	0.064	3.0	2.71	6.4	90	1.29	98.6
4	0.034	3.0	2.96	6.0	92	1.43	98.5

[a] Specific gravity = 0.97.

[b] Specific gravity = 1.04.

TABLE 4-5. PARTICLE SIZE RESULTS

Results[a]	Impactor stage 1	2	Cyclone	Filter
Nominal size range (microns)[b]	> 10	5-10	1-5	< 1
Run 1 (baseline)				
Net weight (mg) corrected	3.20	2.20	2.85	49.78
Fraction (% of total)	5.51	3.79	4.91	85.78
Cumulative % (with filter)	5.51	9.31	14.22	100.00
D_{50} size (microns)[c]	10.20	5.61	1.38	0.01
Geometric mean diameter[d] (microns)	14.3	7.56	2.78	0.167
Run 4 (elevated metals)				
Net weight (mg) corrected	3.36	3.52	7.35	64.6
Fraction (% of total)	4.26	4.46	9.32	81.95
Cumulative % (with filter)	4.26	8.73	18.05	100.00
D_{50} size (microns)[c]	9.61	5.22	1.22	0.01
Geometric mean diameter[d] (microns)	13.9	7.08	2.53	0.160

[a] Additional support data are provided in Appendix B-2.

[b] Microns = Presented in units of aerodynamic particle diameter by assuming a particle density of 1 g/cc.

[c] D_{50} = The particle diameter associated with the 50% collection efficiency level for each size-classifying stage as determined by theoretical calculations or by calibration.

[d] GMD = Geometrical mean diameter, the single value representation of the particle size range collected on each size-classifying stage, determined by the equation (assumed largest particle is 20 microns and 0.01 microns is smallest):

$$(GMD)^n = \sqrt{(D_{50})_n \times (D_{50})_{n+1}}$$

where n = Stage of concern.
n+1 = The upper stage next to the stage in question.

Note: Calculated particulate loadings were 0.02105 gr/dscf (measured at 25.6% isokinetic sampling) and 0.02823 gr/dscf (measured at 26.9% isokinetic sampling) for Runs 1 and 4, respectively.

A general concern of any acid-neutralizing scrubbing system is that salts formed in the process may be entrained in the gas stream and carry over through the entire air pollution control system. This is possible because salt fumes, which consist of very small particles, may be formed upon reaction of acid gases and the neutralizing medium (i.e., caustic). Particles in this size range would not likely be efficiently removed by the venturi or may form after the venturi. Such salt particles may have increased the mass collected in the smaller size ranges.

The total particulate loading results for the particle size train were slightly higher (7% and 33% for Runs 1 and 4) than the results for the multiple metals train. This shows very good agreement considering the much lower volumetric sampling rates that were unavoidable for the particle size train and the fact that it is a single point sampling method.

4.3 METALS EMISSIONS AND CONTROL EFFICIENCY

This section summarizes the results of sampling and analysis for metals, including arsenic (As), cadmium (Cd), chromium (Cr), and lead (Pb). Section 4.3.1 discusses the total input and output rates for each metal and the control (removal) efficiency of the scrubber system. Section 4.3.2 discusses the results of metals analysis of the particle sizing train samples. Finally, Section 4.3.3 discusses the results of sampling and analysis for hexavalent chromium (Cr^{+6}).

4.3.1 Metals Throughput and Control Efficiency

The testing for metals consisted of a single baseline run and triplicate runs with elevated metals input rates. For the elevated metals runs, additional metals were spiked into streams fed to the combustion chamber. Cadmium, chromium, and lead were added via an aqueous spiking solution injected into the tempering water feed to the combustion chamber. Arsenic could not be spiked in the same manner due to reaction of the arsenic with other spiking components and formation of a precipitate. Therefore, the arsenic was added to the aqueous waste feed tank.

The concentrations of metals in the feed streams are provided in Appendix B-3. Arsenic in the aqueous waste was present at 1.4 µg/g in the baseline run (Run 1) and after spiking was increased to 2.6 to 3.0 µg/g for the elevated metals runs (Runs 2 to 4). This was the primary input of arsenic to the incinerator. The metals spiking solution used for Runs 2 to 4 contained 1,700 to 2,000 µg/g cadmium, 4,400 to 10,500 µg/g chromium, and 520 to 760 µg/g lead. The organic waste contained a larger amount of chromium for the baseline run, at a concentration of 5.2 µg/g than the other runs. The other aqueous streams (city water used for tempering water, quench water, and scrubber water, and the scrubber alkali) contained small amounts of arsenic, cadmium, and chromium. Lead was also present in these streams, particularly in the scrubber alkali in Runs 1 and 4 (9.8 and 3.2 µg/g, respectively). These levels provided a significant contribution to the total input rate for lead.

Table 4-6 shows all the metals input rates for waste and process streams fed to the combustion chamber and scrubber, and the metals output rates for the scrubber effluent. Results for Run 1 (no metals spiking) reflect the presence of arsenic in the aqueous waste and chromium in the organic waste. As noted above, lead was also found in the scrubber streams, particularly the alkali feed to the scrubber. The metals spiked in Runs 2, 3, and 4 elevated the levels of arsenic in the aqueous waste and the level of other metals in the tempering water. Input rates of metals to the scrubber were relatively small compared to the combustion chamber input rates, except for lead. The lead in the scrubber feed complicated the calculation of control device efficiency for that metal as discussed later. The total input vs. output rates on Table 4-6 did not show a good balance.

Table 4-7 shows the blank corrected stack emission rates. As described in Section 3.4, blank values from analysis of the proof rinses of the sampling train were subtracted from sample values. (Blank values and uncorrected sample values are provided in Appendix B-3.) Blank values were small compared to sample values except for lead on the front half of the sample train, where the sample values were less than twice blank values. This resulted in the range of values for the emission rate of lead shown on Table 4-7. The minimum value

TABLE 4-6. METALS INPUT/OUTPUT RATES (EXCLUDING STACK OUTPUT)

Stream	Rates, mg/min															
	Run 1 (baseline)				Run 2				Run 3				Run 4			
	As	Cd	Cr	Pb	As	Cd	Cr	Pb	As	Cd	Cr	Pb	As	Cd	Cr	Pb
Inputs to combustion chamber																
Organic waste	0	0	57	0	0	0	20	0	0	0	18	0	0	0	11	0
Aqueous waste[a]	36	1	6	2	81	0	7	12	66	0	3	4	62	0	7	7
Tempering water[b]	0	0	0	0	0	112	289	39	0	122	646	46	0	115	296	36
Total	36	1	63	2	81	112	316	51	66	122	667	50	62	115	314	43
Inputs to scrubber																
Quench water	0	2	5	16	0	2	5	15	0	2	5	16	0	2	6	16
Scrubber feed water	0	2	7	20	0	2	5	14	0	2	5	14	0	2	7	19
Scrubber alkali	0	0	7	71	7	0	10	0	10	0	5	9	5	1	8	33
Total	0	4	19	107	7	4	20	29	10	4	15	39	5	5	21	68
Outputs																
Scrubber water effluent	64	0	159	191	152	71	289	57	136	84	513	353	126	104	305	48

[a] Spiked with arsenic in Runs 2, 3, and 4.

[b] Spiked with cadmium, chromium, and lead in Runs 2, 3, and 4.

TABLE 4-7. STACK EMISSIONS OF METALS

Run	Blank corrected emission rate,[a] mg/min			
	As	Cd	Cr	Pb[b]
1 (baseline)	0.4	0.8	1.1	1.5-2.9
2	0.9	1.3	2.1	1.3-2.0
3	0.8	1.6	4.3	1.2-1.8
4	0.8	1.8	3.9	0.7-1.5

[a] Blank corrected using proof rinse sample from multiple metals sampling train.

[b] Sample values were less than twice the blank values. Range of values represents alternative blank correction procedures.

for the range was calculated by adding the blank corrected front half sample value (which results in a zero or near zero value) to the blank corrected back half value. The maximum value was calculated by adding the front half sample value (without blank correcting) to the blank corrected back half value. The true value should be somewhere within the range presented.

The majority of the metals emissions were found in the front half samples (i.e., probe rinse and filter) for the elevated metals runs. Nearly all of the arsenic was found on the front half for two of three runs. About 70% to 80% of the cadmium and 80-95% of the chromium was found on the front half. For lead, high blank values presented a similar comparison.

Table 4-8 presents the estimated metals removal efficiencies for the control device (quench followed by a venturi scrubber and packed tower). For the efficiency calculation, the control device inlet rate was estimated to be equal to the input of metals to the combustion chamber (aqueous waste, organic waste, and tempering water including the spike solution). This should provide a reasonable estimate of efficiency when the metals input rate for the scrubber and quench feed water is small relative to the metals input rate for the combustion chamber. This was the case for all metals except lead. For lead, it is possible that some of the metal in the scrubber feed water contributed to the stack emissions. This would result in a higher measured stack emission rate than the rate attributable to penetration of the scrubber by metal fed to the incinerator. The value calculated for lead is, therefore, an estimate of the minimum efficiency value.

4.3.2 Metals Distribution by Particle Size

The distribution of metals in the stack gases by particle size was determined by analyzing samples from a particle sizing train operated during Run 1 (baseline conditions) and Run 4. Table 4-9 presents the data on metals by particle size. The distribution of total particulate by particle size is also shown for comparison. Figure 4-2 shows plots of particle size vs. cumulative percent less than the size for each metal along with the particulate distribution for comparison. Only data from Run 4 were plotted on Figure 4-2. Those data should better represent the control device performance than data from the baseline run because larger quantities of the metals were present.

TABLE 4-8. ESTIMATED METALS REMOVAL EFFICIENCIES

Run	% Removal[a] As	Cd	Cr	Pb[b,c]
1 (baseline)	98.8	d	98.3	d
2	98.9	98.8	99.4	96.1-97.4
3	98.8	98.6	99.4	96.3-97.6
4	98.6	98.4	98.8	96.5-98.3
Avg. runs 2-4	98.8	98.6	99.2	96.3-97.8

[a] Based upon blank corrected stack emissions data.

[b] Range reflects range in stack emission rates according to the blank correction procedures.

[c] Minimum efficiency.

[d] Input levels were too low to determine the efficiency.

TABLE 4-9. PARTICLE SIZE DISTRIBUTION OF METALS

Sample name	Size range of fraction (microns)	D50 size (microns)	Geometric mean diameter (microns)	Amount in sample, ug				Distribution by particle size, %					Cumulative distribution by particle size, % less than D50				
				As	Cd	Cr	Pb	As	Cd	Cr	Pb	Part.	As	Cd	Cr	Pb	Part.
Run 1 (baseline)																	
HCSS Stage 1	> 10	10.20	14.3	< 0.0937	0.282	4.09	0.383	0	25	9	2	5	100	75	91	98	95
HCSS Stage 2	5-10	5.61	7.56	< 0.0937	0.166	2.48	0.562	0	15	6	3	4	100	61	85	95	91
HCSS Cyclone	1-5	1.38	2.78	< 0.0937	0.192	6.20	0.141	0	17	14	1	5	100	44	71	94	86
HCSS Final filter	< 1	0.01	0.167	1.81	0.500	30.8	17.7	100	44	71	94	86					
Total detected				1.81	1.14	43.5	18.8										
Run 4																	
HCSS Stage 1	> 10	9.61	13.9	0.211	1.08	20.0	1.38	4	7	8	7	4	96	93	92	93	96
HCSS Stage 2	5-10	5.22	7.08	1.06	0.614	32.2	0.256	20	4	13	1	5	75	89	79	92	91
HCSS Cyclone	1-5	1.22	2.53	0.365	5.43	109	0.652	7	35	43	3	9	68	54	37	88	82
HCSS Final filter	< 1	0.01	0.160	3.54	8.31	93.5	17.5	68	54	37	88	82					
Total detected				5.17	15.4	255	19.8										
Reagent Blanks--Run 1																	
Blank acetone				0.269	< 0.00236	0.233	0.0895										
Blank filter				0.307	0.0242	3.41	15.6										
Total detected				0.577	0.024	3.65	15.7										
Reagent Blanks--Run 2																	
Blank acetone				< 0.0937	< 0.00236	0.179	< 0.0520										
Blank filter				0.231	0.0298	3.77	15.3										
Total detected				0.231	0.0298	3.94	15.3										

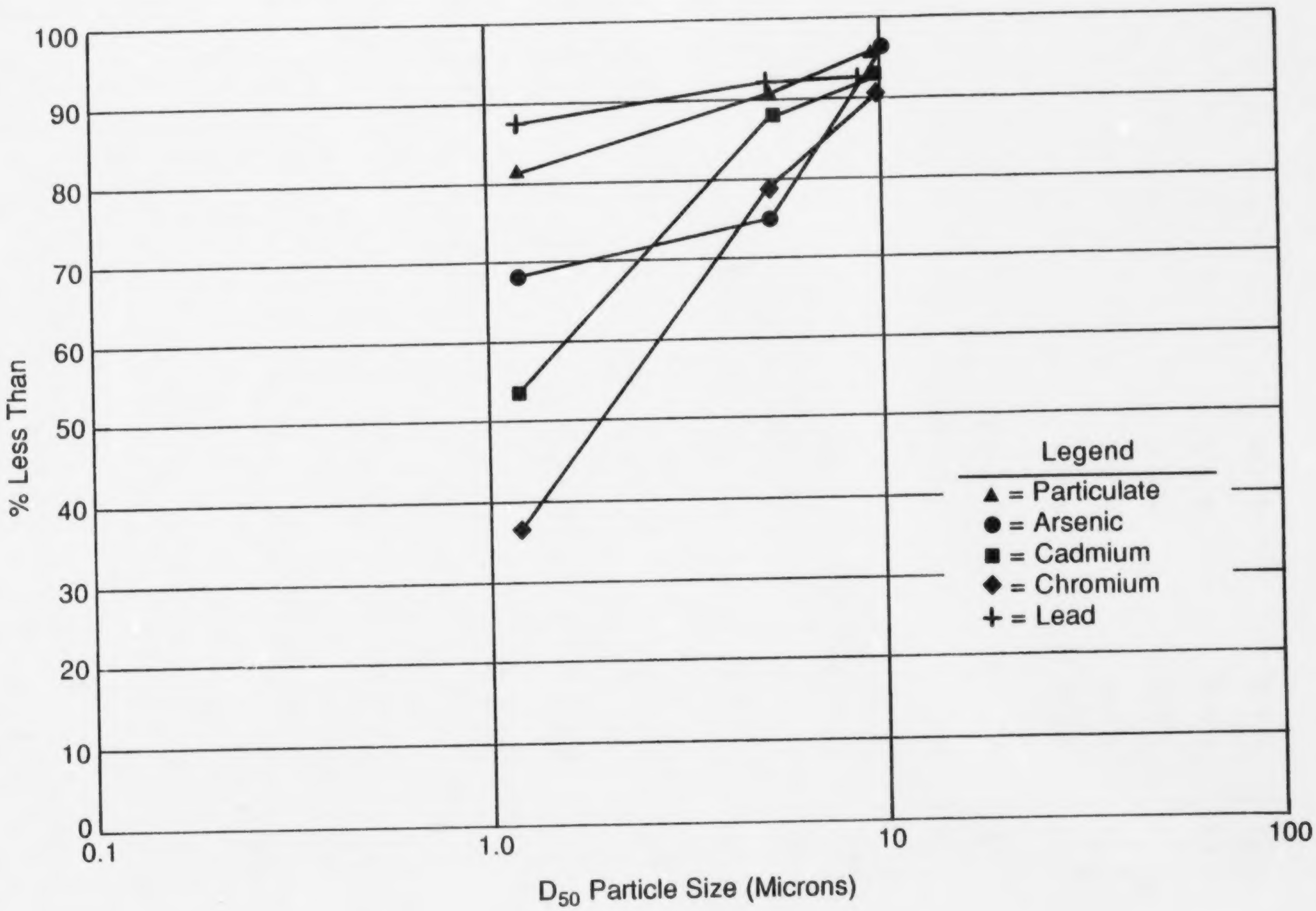

Figure 4-2. Percent less than vs. D_{50} particle size, Run 4.

The metals results by particle size were not blank corrected; however, the two sets of blank values are shown in Table 4-9. The blank values were all low relative to sample values except for lead.

Blank filter values for lead were almost as high as the sample train filter values, thus the submicron lead values may be artificially high. The final filter stage of the sampling train accounted for most of the lead found.

The validity of the data on chromium by particle size was of concern because the samples were collected in a stainless steel sampling device. Stack gas concentrations calculated from the particle size train were 7 to 11 times higher than concentrations from the multiple metals train, as shown in Table 4-10. This suggests that some contamination occurred, resulting in a bias in the results for chromium.

4.3.3 Hexavalent Chromium Results

Analysis for hexavalent chromium (Cr^{+6}) was performed on two types of samples, stack gas impinger samples from a special sampling train and scrubber effluent samples. No Cr^{+6} results were obtained for either group of samples. The sampling and analysis methods that were used failed to provide valid results. Appendix A-2 contains a discussion of the problems encountered.

4.4 ORGANIC EMISSIONS

A wide array of sampling and analysis (S&A) techniques were employed (as described in Section 3.3) to measure the total mass of organic compounds emitted from the incinerator stack during Runs 5-10. Most of the techniques were designed to provide a value for the mass of emissions without identifying specific compounds. The mass was quantified within boiling point ranges, which roughly equates to ranges in the number of carbon atoms in organic compounds, using EPA Level 1 techniques. This mass measurement was compared to measurements made with total hydrocarbon (THC) monitors. A few specific compound analyses were made for low molecular weight compounds that are potentially present in incinerator stack gases at the highest concentrations. These compounds were formaldehyde, methane, ethane, ethylene, and acetylene.

TABLE 4-10. METALS CONCENTRATIONS IN STACK GAS

Run no.	Train	Stack gas concentration (μg/dscm) As	Cd	Cr	Pb
1	Multiple metals[a]	2.2	4.0	5.4	7.7-14.4
	Particle size	1.5	0.9	36.1	15.6
2	Multiple metals[a]	4.4	6.5	10.3	6.5-9.9
3	Multiple metals[a]	4.0	7.9	21.3	6.0-9.2
4	Multiple metals[a]	4.3	9.0	19.5	3.6-7.6
	Particle size	4.2	12.7	209	16.3

[a] Blank corrected.

The following discussion of the results of these measurements is divided into two subsections. The first presents the total organic mass results determined by the Level 1 techniques. The second presents the THC measurements and compares these to the organic mass measurements and to CO levels.

4.4.1 Total Organic Mass Emissions

The EPA Level 1 techniques employ several S&A methods to obtain a measurement of total organic mass. Figure 4-3 shows the various fractions that were separately analyzed. The fractions are identified on the figure by approximate carbon numbers and by the boiling point range associated with the chromatographic analysis. The major fractions separated were C_1-C_7 volatile compounds, C_7-C_{17} semivolatile compounds, and $> C_{17}$ nonvolatile compounds. The volatile fraction is further subdivided into C_1-C_7 condensate (compounds collected in a wet cold trap), C_1-C_2 gaseous compounds, and C_3-C_7 gaseous compounds. These gaseous compounds are those that passed through the condensate trap. Formaldehyde is a C_1 volatile compound, but is shown separately on Figure 4-3 because separate S&A techniques were required. Further subdivision of the semivolatile and nonvolatile fractions will be discussed later because those fractions did not account for a large portion of the total mass.

The mass found for each of the major fractions is shown on Table 4-11 for each test run (see Appendix B for complete data tables). The values shown were all blank-corrected to provide the best estimate of the mass. Sample values that were less than twice the blank value before correction are footnoted to indicate less certainty about their quantitation. The blank values and the correction procedure used are described in Section 3.4.

The total mass summed from the values for each fraction is biased low for two reasons. First, the gas chromatography (GC) analyses for the volatile and semivolatile fractions tend to underestimate the total chromatographable material because the integrator could not clearly separate the smaller peaks from normal baseline drift and noise. Thus, the smallest peaks were not counted in the mass. This is probably more significant for the semivolatile fraction where numerous small peaks are more common. Second, results could not be determined for part of the analytical range in two cases. A water peak in the

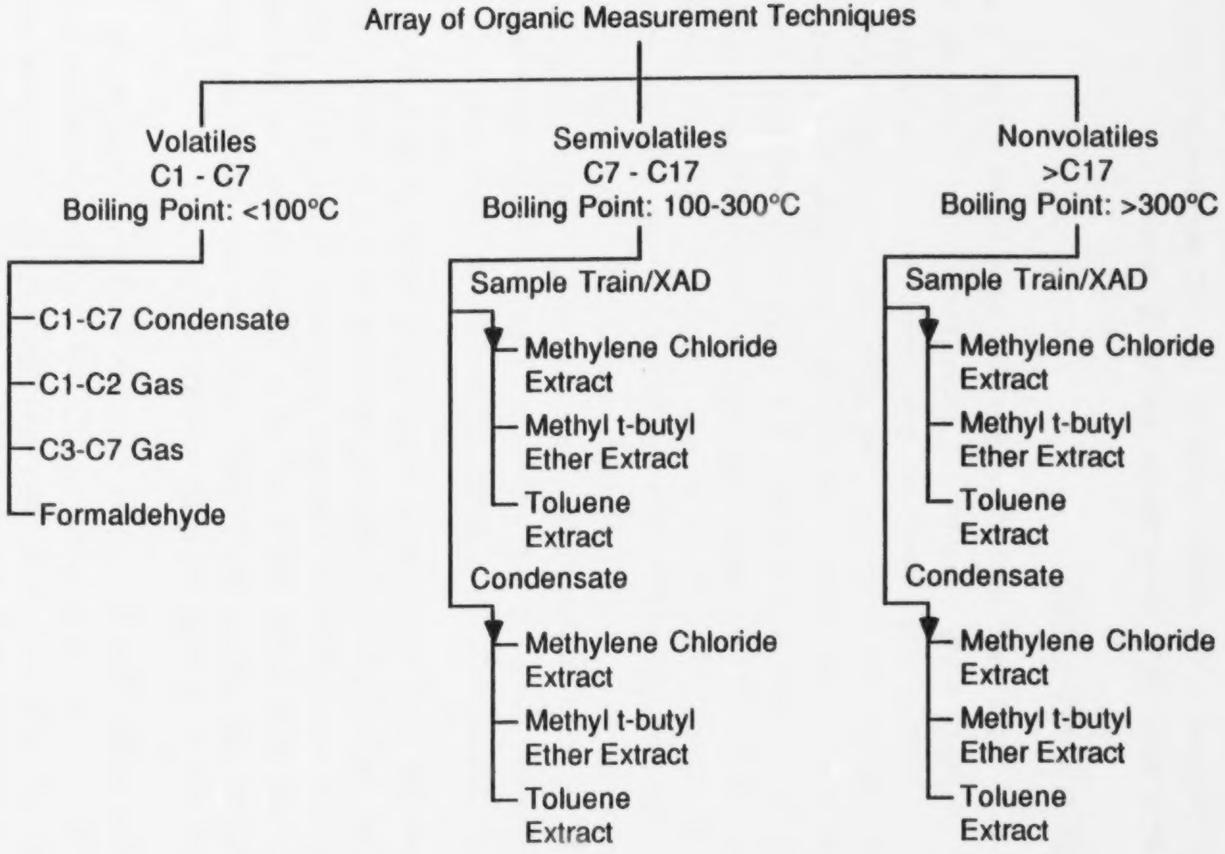
Array of Organic Measurement Techniques
Volatiles
C1 - C7
Boiling Point: <100°C
C1-C7 Condensate
C1-C2 Gas
C3-C7 Gas
Formaldehyde
Semivolatiles
C7 - C17
Boiling Point: 100-300°C
Sample Train/XAD
Methylene Chloride Extract
Methyl t-butyl Ether Extract
Toluene Extract
Condensate
Methylene Chloride Extract
Methyl t-butyl Ether Extract
Toluene Extract
Nonvolatiles
>C17
Boiling Point: >300°C
Sample Train/XAD
Methylene Chloride Extract
Methyl t-butyl Ether Extract
Toluene Extract
Condensate
Methylene Chloride Extract
Methyl t-butyl Ether Extract
Toluene Extract

Figure 4-3. Organic mass fractions.

TABLE 4-11. DISTRIBUTION OF MASS AMONG MAJOR FRACTIONS (ppm AS PROPANE)

Test run	Total mass	Formaldehyde	C_1-C_2 gas	C_3-C_7 gas	C_1-C_7 condensate	Semi-volatiles	Non-volatiles
5	9.1	< 0.00064[a]	0[a]	3.7	2.3	1.5	1.6
6	19.6	0.0028	0[a]	1.0	13.8	1.4	3.4
7	60.2	< 0.0015[a]	1.3[a]	8.8	19.0	29.1	2.0
8	134.4	0.0014[a]	34.1	22.0	70.3	5.9	2.1
9	24.6	< 0.0019[a]	9.1	1.4	6.6	6.0	1.5
10	46.4	0.0024	7.3	6.0	30.8	1.0[a]	1.3
Avg.	49.1	0.0018	8.6	7.2	23.8	7.5	2.0

[a] Sample value was less than twice the blank value.

volatile bag condensates obliterated any C_1 or C_2 peaks that may have been present. Also, carry over of the three solvents used to extract the semivolatile samples required that all peaks from C_7-C_9 be rejected. Some of the samples showed large peaks in this area but they could not be differentiated from the extraction solvent peaks.

The distribution of mass between the major fractions is shown in Table 4-12 for each test run and as an average for all six runs. There is some variation in the distribution from run to run, but few obvious trends were observed that distinguish the different combustion conditions or CO levels. Two trends that can be seen on Table 4-12 are that during the earlier runs the C_1-C_2 gas accounted for a smaller percent of the total mass and the nonvolatiles accounted for a larger percent than during the later runs. The incinerator operated at better combustion conditions (lower CO) during the earlier runs. For the C_1-C_2 gas fraction, Table 4-11 shows that the lower percentage reflects lower mass emissions during the better combustion conditions. For the nonvolatile fraction, the higher percentage reflects a relatively constant mass emission rate regardless of the combustion conditions. The distribution on Table 4-12 also consistently showed that the majority of the mass is in the volatile fractions, with small percentages in the semivolatile and nonvolatile fractions. Figure 4-4 displays this distribution, using the average data from Table 4-12. Variation in the total mass from run to run is discussed in Section 4.4.2 along with the THC results.

Additional data were gathered on specific organic compounds in the C_1-C_2 fraction (methane, ethane, ethylene, and acetylene). These are the only hydrocarbons (carbon/hydrogen compounds) possible in this fraction. Table 4-13 shows the results for these compounds. Very little methane was present in any run except Run 8, when the incinerator was operating under the worst combustion conditions (high CO, lowest temperature). Essentially, no ethane was present in any run. Low levels of ethylene and acetylene were identified in Runs 8, 9, and 10.

TABLE 4-12. DISTRIBUTION OF MASS AMONG MAJOR FRACTIONS (% OF TOTAL MASS)

Test run	C_1-C_2 gas	C_3-C_7 gas	C_1-C_7 condensate	Semivolatiles	Nonvolatiles
5	0.0	40.7	25.3	16.5	17.6
6	0.0	5.1	70.4	7.1	17.3
7	2.2	14.6	31.6	48.3	3.3
8	25.4	16.4	52.3	4.4	1.6
9	37.0	5.7	26.8	24.4	6.1
10	15.7	12.9	66.4	2.2	2.8
Avg.	17.5	14.7	48.5	15.3	4.1

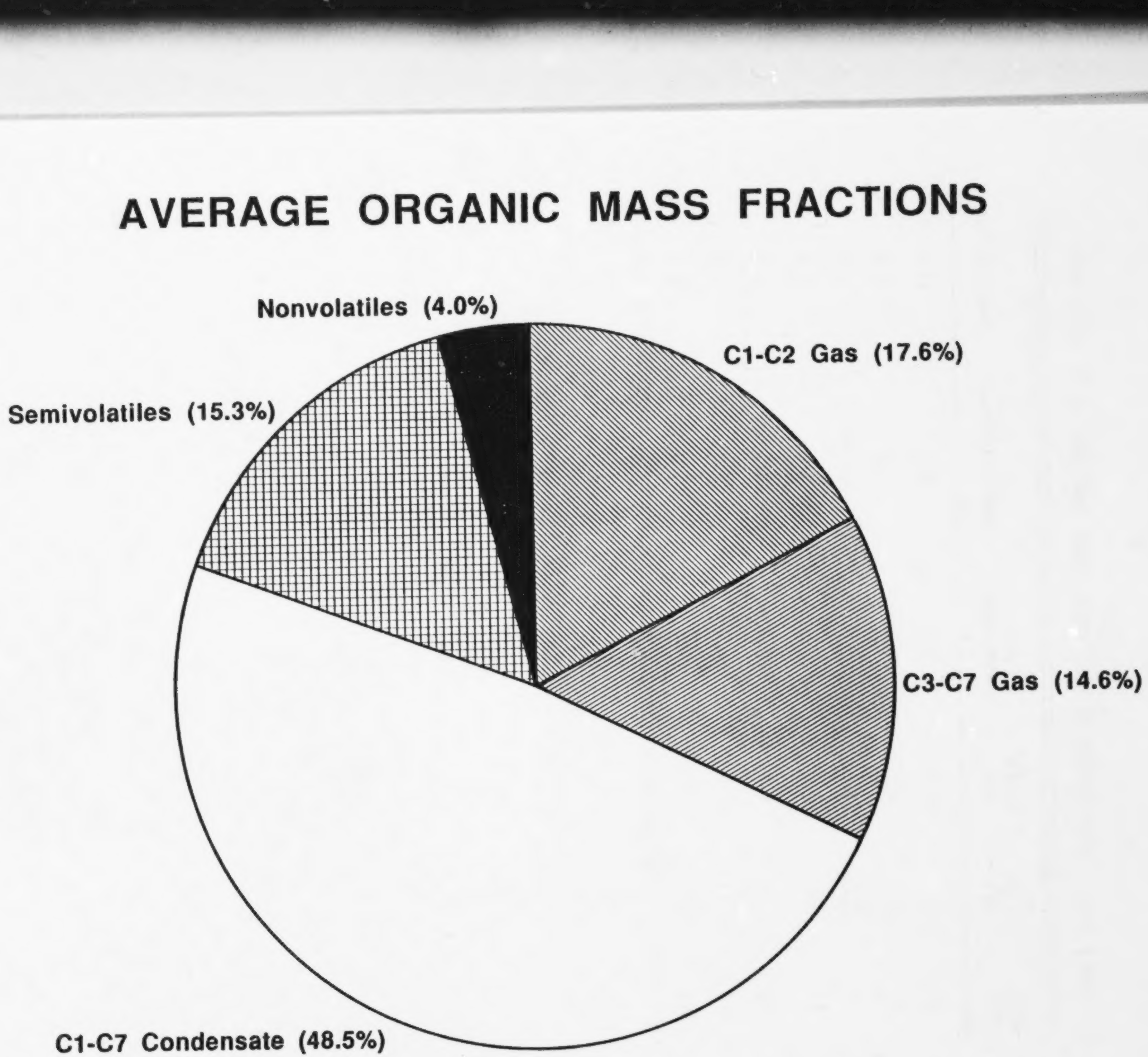

Figure 4-4. Average organic mass fractions.

TABLE 4-13. C_1 AND C_2 VOLATILE COMPOUNDS

Run	Methane		Ethane		Ethylene		Acetylene	
	ppm, propane	ppm, methane	ppm, propane	ppm, ethane	ppm, propane	ppm, ethylene	ppm, propane	ppm, acetylene
5	0[a]	0[a]	0[a]	0[a]	0	0	0	0
8S	1.09[a]	3.51[a]	0.03[a]	0.05[a]	0.02	0.04	0	0
6	0[a]	0[a]	0[a]	0[a]	0.01	0.02	0	0
7	1.12[a]	3.62[a]	0.05[a]	0.08[a]	0.14	0.26	0	0
8	31.09	100.83	0[a]	0[a]	1.23	2.22	1.81	2.57
9	7.79	25.24	0.02[a]	0.03[a]	1.10	1.97	0.18	0.25
10	5.64[a]	18.26[a]	0[a]	0[a]	1.52	2.73	0.28	0.40

[a] Sample value was less than twice the blank value.

An additional short (about 20 min) test run (8S) was conducted to evaluate any effect on the volatiles emissions (particularly methane) from using natural gas vs. fuel oil as the auxiliary fuel. Table 4-14 shows the comparative results from burning natural gas during Run 8S and Run 5 where operation of the incinerator was similar, except fuel oil was burned. Burning natural gas may have had a slight effect, particularly on the C_1-C_7 condensate fraction. However, the CO level during Run 8S was slightly higher than during Run 5, which may have contributed to the small differences seen. In general, the difference in volatile organic emissions (including methane) between these two runs is small compared to differences across the test series.

Data were also available to evaluate the distribution within the semivolatile and nonvolatile fractions. Both of these fractions were divided between a sample train/XAD (compounds collected in the front of a MM5 train and on the XAD resin) and condensate (compounds that passed the front of the train and XAD resin, but were collected in a water condensate trap) component. These two components were each sequentially extracted in order with methylene chloride, methyl *t*-butyl ether, and toluene. The diagram in Figure 4-3 showed the resulting six fractions for the semivolatile and nonvolatile analyses.

Table 4-15 shows the distribution of mass among the semivolatile fractions. The distribution for Runs 5, 6, 7, and 10 shows that most of the mass was found in the condensate. The distribution for Runs 8 and 9 are similar, but have a very different distribution than the other runs. Ninety percent of the mass in Run 8 and 65% in Run 9 was collected in the train and XAD resin and was extracted by the methylene chloride.

Table 4-16 shows the distribution for the nonvolatile fractions. In this case a more consistent portion of the mass (31% to 73%) was collected in the sample train and XAD resin and was extracted by the methylene chloride. Essentially, no additional mass was found in the methyl *t*-butyl ether and toluene extracts of the sample train and XAD. The distribution in the condensate among the three extracts varied from run to run.

TABLE 4-14. VOLATILES EMISSIONS WITH ALTERNATE AUXILIARY FUELS

Run	CO, ppm corrected to 7% O_2	Auxiliary fuel	Volatile organics, ppm as propane							
			C_1-C_2	C_3-C_7	C_1-C_7 condensate	Total volatiles	Methane	Ethene	Ethylene	Acetylene
5	111	Fuel oil	0[a]	3.7	2.3	6.0	0[a]	0[a]	0	0
8S	168	Natural gas	1.1[a]	5.5	11.0	17.6	0.7[a]	0.03[a]	0.02	0

[a] Sample value was less than twice the blank value.

TABLE 4-15. DISTRIBUTION OF SEMIVOLATILE ORGANICS

Test run	Total)g found	% in each fraction[a]					
		Sample train/XAD			Condensate		
		Methylene chloride extract	Methyl t-butyl ether extract	Toluene extract	Methylene chloride extract	Methyl t-butyl ether extract	Toluene extract
5	6,138	3[b]	0[b]	5[b]	9	31	52
6	4,600	2[b]	0[b]	11[b]	13	22	53
7	124,254	0[b]	0[b]	0[b]	70	21	9
8	23,036	94	0[b]	0[b]	4	2	1[b]
9	23,899	65	0[b]	3[b]	2	13	17
10	3,949	5[b]	0[b]	18[b]	8[b]	35	36
Avg.	-	28	0	6	18	21	28

[a] Blank-corrected values.

[b] Sample value less than twice the blank value.

TABLE 4-16. DISTRIBUTION OF NONVOLATILE ORGANICS

		% in each fraction[a]					
		Sample train/XAD			Condensate		
Test run	Total)g found	Methylene chloride extract	Methyl t-butyl ether extract	Toluene extract	Methylene chloride extract	Methyl t-butyl ether extract	Toluene extract
5	14,055	60	0^b	0^b	12	16	13
6	23,656	60	0^b	0^b	22	7	12
7	17,378	51	0^b	1^b	0^b	1	47
8	17,050	73	0^b	1^b	16	3^b	7
9	12,376	31	0^b	0^b	19	22	29
10	10,783	41	0^b	0^b	39	5^b	14
Avg.	-	53	0	0	18	9	20

[a] Blank-corrected values.

[b] Sample value less than twice the blank value.

4.4.2 Total Hydrocarbon Emissions

THC emissions were measured by two different techniques identified here as hot and cold THC. The primary difference was that the hot THC had a sample line and instrument heated to 150°C and the cold THC had an ice cooled condensate trap near the stack sampling port and an unheated sample line. Both used a flame ionization detector (FID) as did the organic GC analyses. Both techniques are described in Appendix A. The cold THC technique was more closely representative of historical THC monitoring techniques. The hot THC technique was under consideration as a measurement technique for amended hazardous waste incinerator regulations.

Table 4-17 shows the results for both the hot and cold THC monitors compared to CO levels and the Level 1 organic mass for each test run. It can be seen that the THC as measured by the hot and cold technique differed considerably. The difference was greater for the test runs with lower CO levels than for the runs with higher CO levels. Figure 4-5 shows this trend in a plot of the ratio of hot to cold THC vs. CO level. The ratio tended to decrease at higher CO levels.

The difference between the two techniques could not be fully explained, however, two contributing factors were identified. First, the condensate trap on the cold THC removed organics (probably water soluble compounds) from the sampled gas before this gas reached the FID detector. The condensate was similar to the condensate collected with the gas bag samples for volatile GC analysis. That fraction of the total organic mass measured was large (about 50%) as discussed earlier, however, it was not large enough to explain the difference between the two THC techniques.

The second factor is that the hot THC results are probably biased high. The analyzer had severe instability (especially after Run 6), which was later traced to a buildup of condensible matter between the FID capillary and the pressure regulator (after the FID detector). As a result the FID capillary operated at a higher pressure than indicated on the control gauge. With dry span gas the FID readings varied over a 3:1 range depending on flow. Sample gas with 50% moisture would have shown an even greater effect because most of

TABLE 4-17. THC RESULTS

Run	CO, ppm Uncorrected	Corrected 7% O_2	Cold THC, ppm as propane Average	Range	Hot THC, ppm as propane Average	Range	Ratio hot/cold THC	Total organic mass, ppm as propane
5	125	111	3.6	2.2-6.4	36	8.6-58	10	9.1
8S	196	168	6.7	5.7-7.4	51	49-54	7.6	-
6	511	460	12	9.7-19	88	41-104	7.3	20
7	1099	1068	7.6	5.5-10	207	28-284	27	60
8	2460	2464	61	7.5-118	227	84-377	3.7	134
9	3705	2762	61	42-101	199	123-291	3.4	25
10	2458	2128	18	13-28	86	67-109	4.8	46

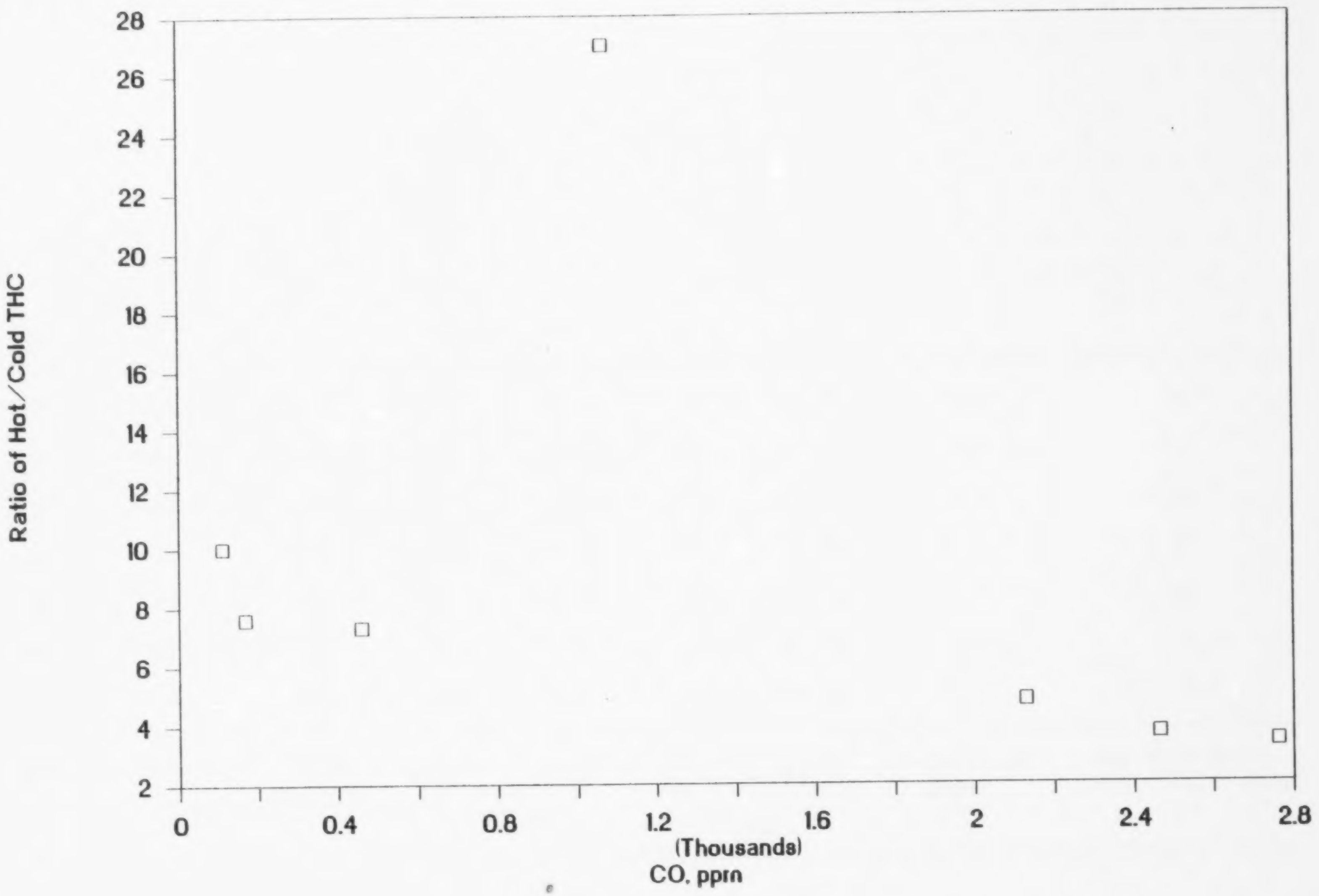

Figure 4-5. CO vs. ratio of hot/cold THC.

the moisture was condensing after the restriction. The wet basis hot THC readings (about half the dry readings) are perhaps closer to the correct value because the additional pressure differential caused by the condensing moisture is approximately proportional to the correction to dry THC basis. Attempts to locate the problem and to compensate for the problem were made during the testing. In Runs 9 and 10 a modified calibration procedure was used to partially correct for the bias. The probable result was that the high bias became more severe until Run 9 when it began to moderate.

Another aspect of both the hot and cold THC readings is that there is no blank correction as there is for the GC and gravimetric methods. During the GC analyses both air and water showed false positive peaks. Although probably not large, a similar false THC signal would be expected.

Figure 4-6 shows a comparison of the cold THC, hot THC, and total organic mass for each test run. The hot THC value was consistently the highest of the three, ranging from 2 to 8 times higher than the total organic mass. However, the earlier discussions about the high bias for the hot THC and the low bias for the total organic mass suggest that these two measurements may be in better agreement than Figure 4-6 indicates. The cold THC was typically lower than the total organic mass, indicating that some organic mass emissions are not detected with the cold THC technique used. Some of these nondetected emissions would be those collected in the condensate trap. Table 4-18 shows the cold THC values compared to the total organic mass and the organic mass less the volatile (C_1-C_7) condensate fraction. The volatile condensate fraction appears to explain the difference for some test runs, but the data are not consistent.

The THC levels were also compared to CO levels for the test series. Figure 4-7 shows a plot of CO concentration in the stack gas (uncorrected for O_2, dry) vs. both the hot and cold THC concentrations. The uncorrected CO values were plotted (instead of CO corrected to 7% O_2) to provide comparable data to the THC values. The plot shows a tendency for THC emissions to increase as the CO level increases, but no strong correlations were observed. There is more scatter for the hot THC values, which probably reflects the difficulties with the hot THC monitor described earlier.

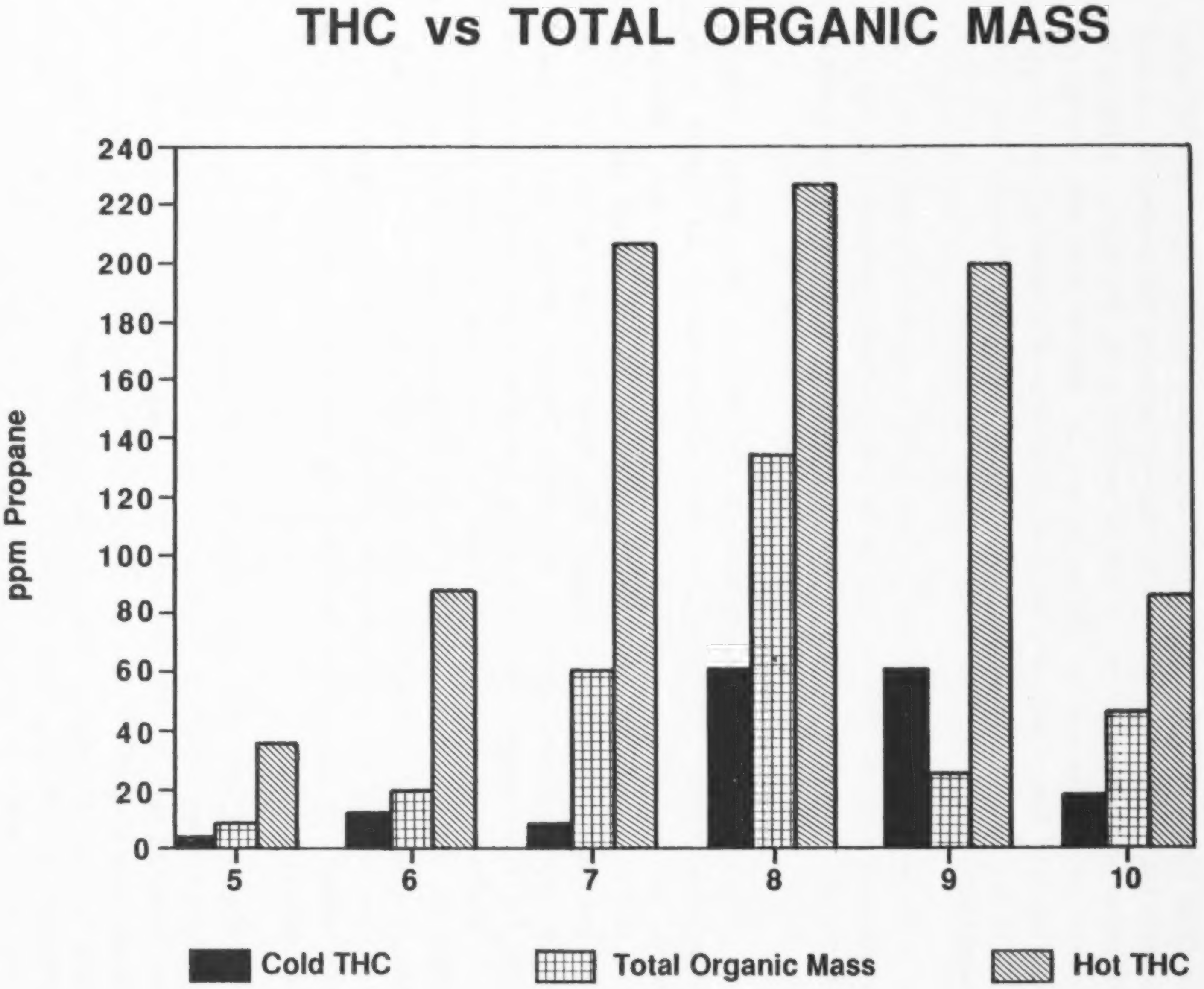

Figure 4-6. Comparison of total organic mass and THC measurements.

TABLE 4-18. COLD THC VS. ORGANIC MASS (ppm AS PROPANE)

Run	Cold THC	Total organic mass	Total organic mass less volatile condensate
5	3.6	9.1	6.8
6	12	20	6.2
7	7.6	60	41
8	61	134	64
9	61	25	18
10	18	46	15

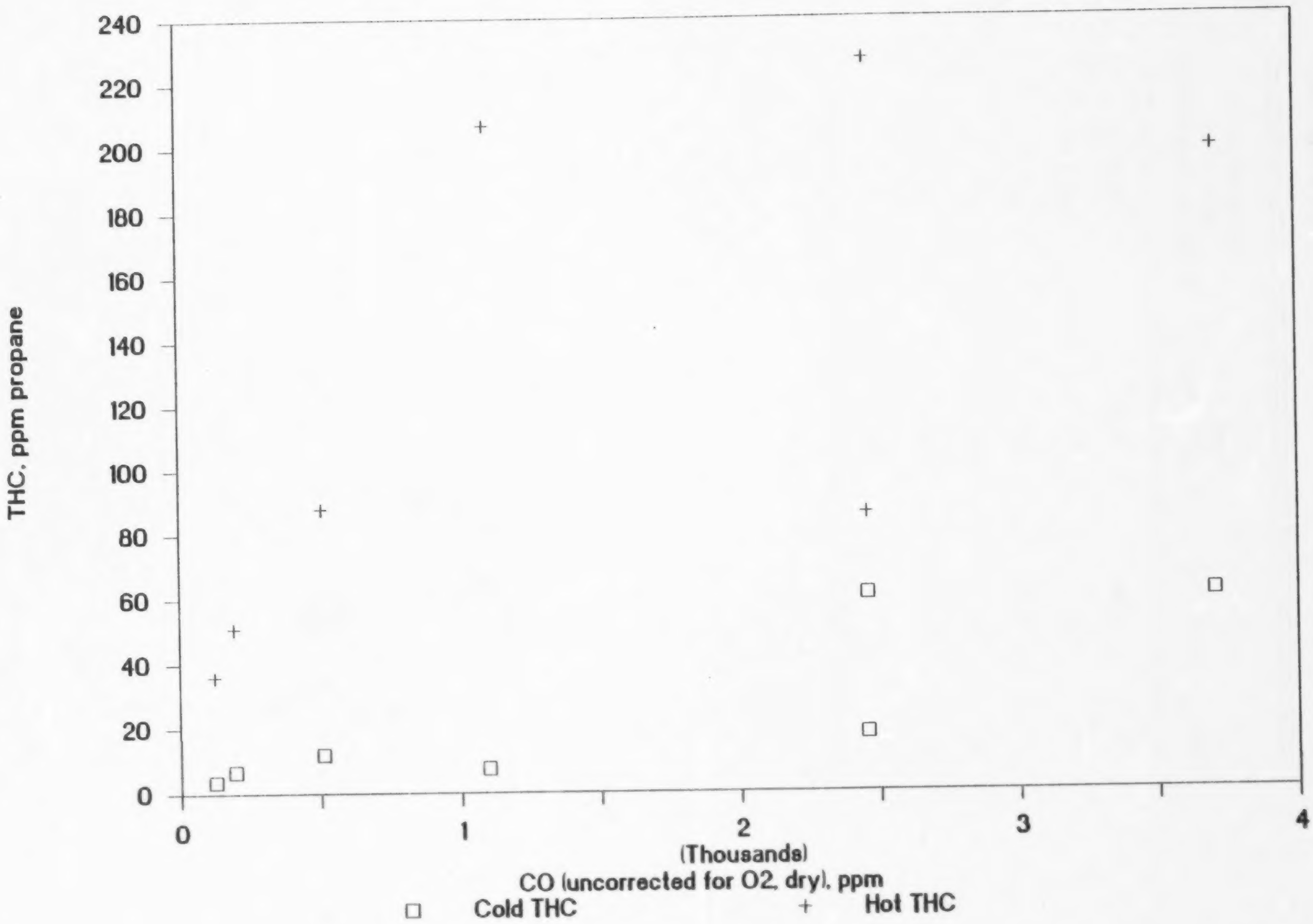

Figure 4-7. CO vs. THC.

APPENDIX A

SAMPLING AND ANALYTICAL PROCEDURES

This appendix contains a summary of sampling and analytical procedures used during the Mobay test program and quality assurance results. Raw data from the methods described are contained in Appendix B.

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APPENDIX A-1

SAMPLING METHODS

SECTION 1.0

SAMPLING PROCEDURES FOR METAL AND PARTICULATE

1.1 PROCESS FEED SAMPLING

The organic liquid waste and aqueous waste feed streams were sampled during the metals testing. These streams were sampled individually from feed lines to the incinerator. More detailed discussions of the sampling location and methods are presented below.

1.1.1 Sample Container Preparation

Containers for these feed samples were prepared in the laboratory prior to the tests. The containers were new clear or amber borosilicate glass bottles with Teflon® screw-cap liners. No glue was used to attach the liners to the caps. Bottles and liners were prepared as follows:

1. Hot water rinse
2. Soak in hot Acationox® solution or equivalent
3. Distilled deionized water rinse (3X)
4. Soak in 10% (v/v) nitric acid solution for at least 8 h
5. Distilled deionized water rinse, ASTM Type I (3X)
6. Air dry or oven dry at 105°C
7. Sealed with color-coded cap for "metals"

Steps 4 and 5 were excluded for nonmetals sample containers, and the caps were coded for "clean."

1.1.2 Organic Liquid Waste Feed Sampling

Organic liquid waste feed samples were taken from a valved tap located directly in line and immediately prior to the burner. The sampling tap and connections between the tap and the main feed line were flushed (allowed to flow to remove stagnant material) each time before samples were collected to ensure sample integrity and representativeness of the waste feed.

Samples were composited by collection directly into 1-L (32-oz) bottles marked for equal volume graduations (e.g., 150-mL increments per bottle for the six grab samples). A grab sample increment for each composite sample was collected every 30 min during a 3-h test run with the first grab being taken at the start of the run and the last grab being taken 30 min before the end of the run. No grab samples were taken during port change. The samples were stored near ice temperature until analysis.

Two composite samples were taken during the initial baseline test (one run) and during each run of the metals removal efficiency test (three runs). One sample from each run was analyzed for arsenic, cadmium, total chromium, and lead. The second sample was analyzed for ash content.

1.1.3 Aqueous Waste Feed Sampling

Aqueous waste feed samples were taken from a valved tap located directly in line and immediately prior to injection into the thermal oxidizer. The sampling tap and connections between the tap and the main feed line were flushed (allowed to flow to remove stagnant material) each time before samples were collected to ensure sample integrity and representativeness of the waste feed.

Samples were composited by collection directly into 1-L (32-oz) bottles marked for equal volume graduations (e.g., 150-mL increments per bottle for the six grab samples). A grab sample increment for each composite sample was collected every 30 min during a 3-h test run with the first grab being taken at the start of the run and the last grab being taken 30 min before the end of the run. No grab samples were taken during port change.

Two composite samples were taken during the baseline run and each of the three metal runs. One sample was analyzed for arsenic, cadmium, lead, and total chromium. The second sample was analyzed for ash content. The samples were stored near ice temperature until analysis or shipment for ash analysis.

1.1.4 Scrubber Water Sampling

The scrubber makeup water (city water) and effluent water were each sampled from valved taps located directly in line and prior to injection (makeup) into the system and after release (effluent) from the system. All sampling taps and connections between the taps and the main feed or effluent lines were flushed (allowed to flow to remove stagnant material) each time before samples were collected to ensure integrity and representativeness of the makeup and effluent waters.

Samples were composited by collection directly into 1-L (32-oz) bottles marked for equal volume graduations. A grab sample increment for each composite sample was collected every 30 min during a 3-h test run with the first grab sample being taken at the start of the run and the last being taken 30 min before the end of the run. The first grab of the effluent water was taken 30 min after the start of the run and the last was taken at the end of the run. No grab samples were taken during port change.

One composite sample of the makeup water was taken during the baseline run. Two composite samples of the effluent waters were taken during the baseline run and each of the three metal runs. For the makeup water, only the composite sample from the baseline run was analyzed for arsenic, cadmium, lead, and total chromium. The effluent water composite sample was analyzed for arsenic, cadmium, lead, and total chromium. The alkaline composite sample of the effluent water was analyzed for hexavalent chromium.

1.2 STACK EMISSIONS SAMPLING

Total mass loadings and mass distribution by particle size of the target metals (arsenic, cadmium, total chromium, and lead) in the stack gas were determined by obtaining samples with Modified Method 5 and Modified Method 17 trains. Hexavalent chromium mass loading was determined by extracting samples with a separate Modified Method 5 train. Particulate matter, diluent gases (carbon dioxide and oxygen), temperature, velocity, moisture content, and volumetric flow rate were also determined as discussed in the following sections. Table A-1 shows the metals sampling trains employed and the parameters sampled with each train. Figure A-1 shows the location of sampling ports and traverse points for the stack location.

1.2.1 Total Metals (Arsenic, Cadmium, Total Chromium, Lead) Mass Loadings and Particulate (MM5 Train)

Particulate and the total mass loading of arsenic, cadmium, total chromium, and lead were determined by samples extracted from the stack gas using a Modified Method 5--Metals (MM5-M) sampling train. The sampling procedure consisted of isokinetically sampling a volume of the stack gas and separating the particulate by filtration in the train and impinging the metals passing through the filter in a nitric acid/hydrogen peroxide absorbing solution. In general, the MM5 sampling procedures paralleled those specified by USEPA, Methods 1 through 5 in 40 CFR 60. For guidance, the draft EMB Metals Protocol, August 1, 1987, titled "Methodology for the Determination of Trace Metal Emissions in Exhaust Gases from Stationary Source Combustion Processes," was used along with MRI's metals testing experience to develop the metals protocol for this test program.

1.2.1.1 Apparatus--

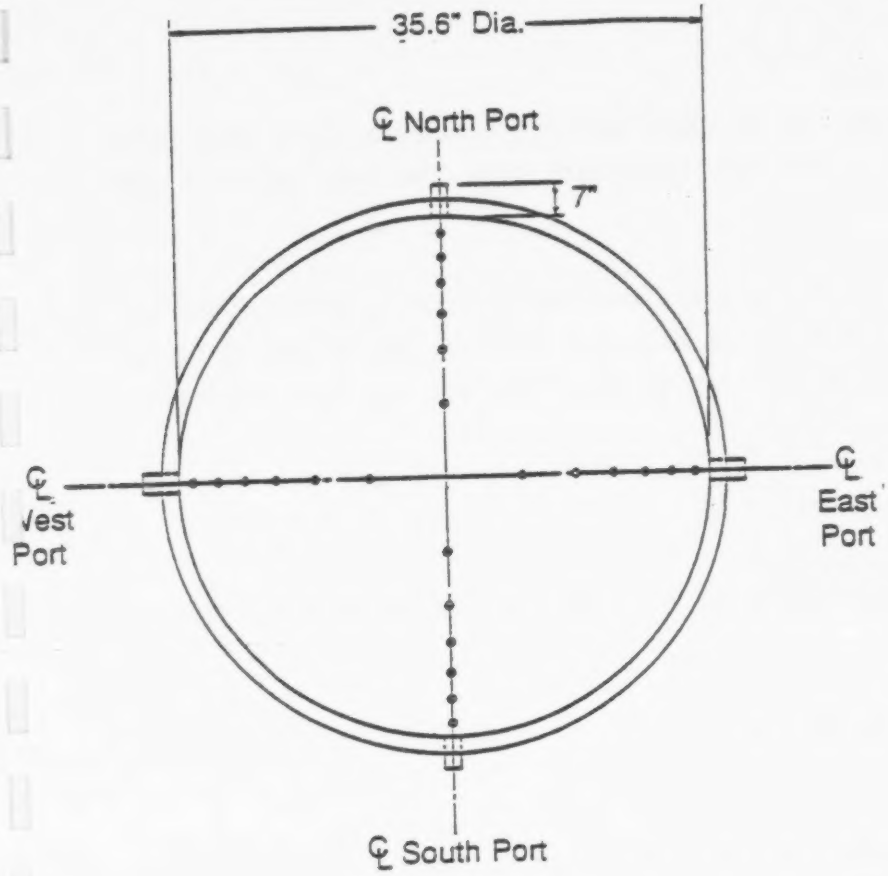
The design of the MM5-M sampling train was based upon the apparatus normally employed in USEPA Method 5, but modified for the special testing requirements. The train consisted of a nickel nozzle, a heat-traced borosilicate glass probe liner housed in a stainless steel sheath and a heated (120° ± 14°C) high efficiency quartz fiber filter (Whatman QM-A) supported on a Teflon®-coated screen mounted in a glass holder. The control module used to control the gas sampling rate and monitor the stack gas parameters contained a leakless vacuum pump, a dry gas meter, an orifice meter, the appropriate valves, gauges, temperature controllers, and associated hardware. The impingers and their contents are described below:

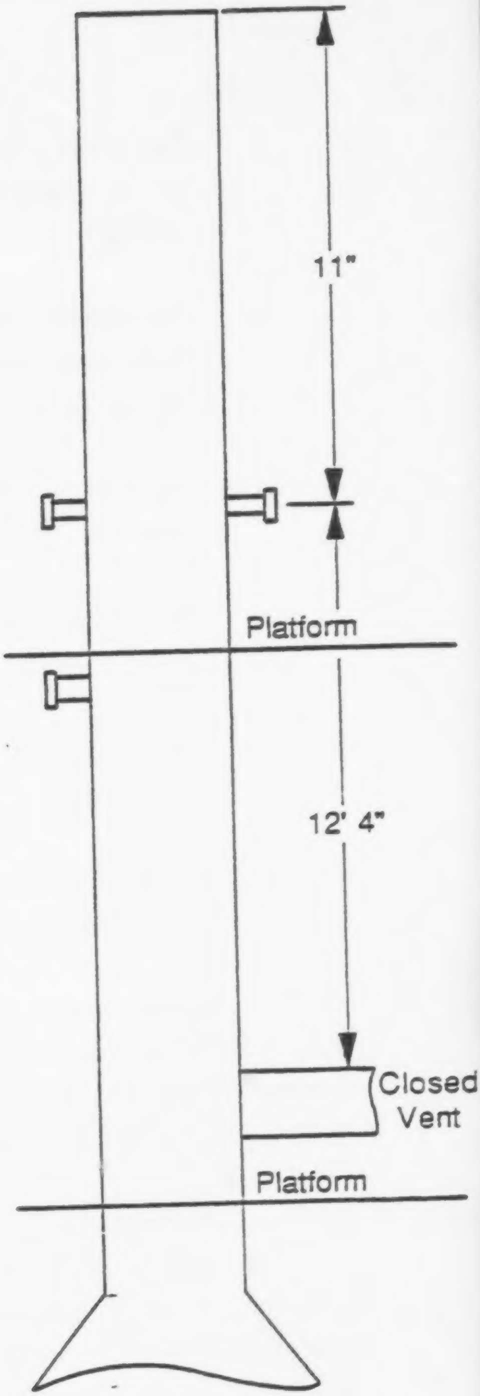
TABLE A-1. DETAIL OF MM5 AND 17 TRAINS

Train type	Data requirements	Test objective[a]	Figure
MM5-M	Arsenic Cadmium Total chromium Lead Moisture Temperature Velocity	A, B	
MM5-Cr(VI)	Hexavalent chromium Moisture Temperature Velocity	A, B	
MM17-M[b]	Arsenic Cadmium Total chromium Lead	A, B	
MM5	Semivolatile organics Moisture Temperature Velocity	C	

[a] A = Baseline test (1 run with no spiking).
B = Metals removal efficiency test (3 runs with metals spiking of aqueous waste).
C = Organics test (6 runs at varying CO levels).

[b] Metals separated and analyzed by particle size distribution.


35.6" Dia.
℄ North Port
7"
℄ West Port
℄ East Port
℄ South Port
N


11"
Platform
12' 4"
Closed Vent
Platform

Traverse Points Across Diameter
Distance from Inside Wall at Port

Point	Inches	Point	Inches
1	1.0*	7	22.9
2	2.4	8	26.7
3	4.2	9	29.3
4	6.3	10	31.4
5	8.9	11	33.2
6	12.7	12	34.6*

*Adjusted Traverse Points

Port Dimensions (Inches)

Port	Length	I.D.
North	7	4
East	7	3
South	7	4
West	7	3
West (Lower)	7	3

Figure A-1. Stack sampling location.

- The first impinger was an empty modified Greenburg-Smith (GBS) with a 2-L capacity to collect condensate from the high moisture gas stream.

- The second and third impingers were GBS with a capacity of 500 mL. Each contained 100 mL of 5% HNO_3 and 10% H_2O_2 (by volume) solution for collection of metals passing the filter and the first impinger.

- The fourth impinger was an empty modified GBS to catch any carryover from the third impinger.

- The fifth impinger was a GBS and contained 100 mL of 0.5 N NaOH as an acid trap.

- The final modified GBS impinger contained about 200 g of indicating silica gel.

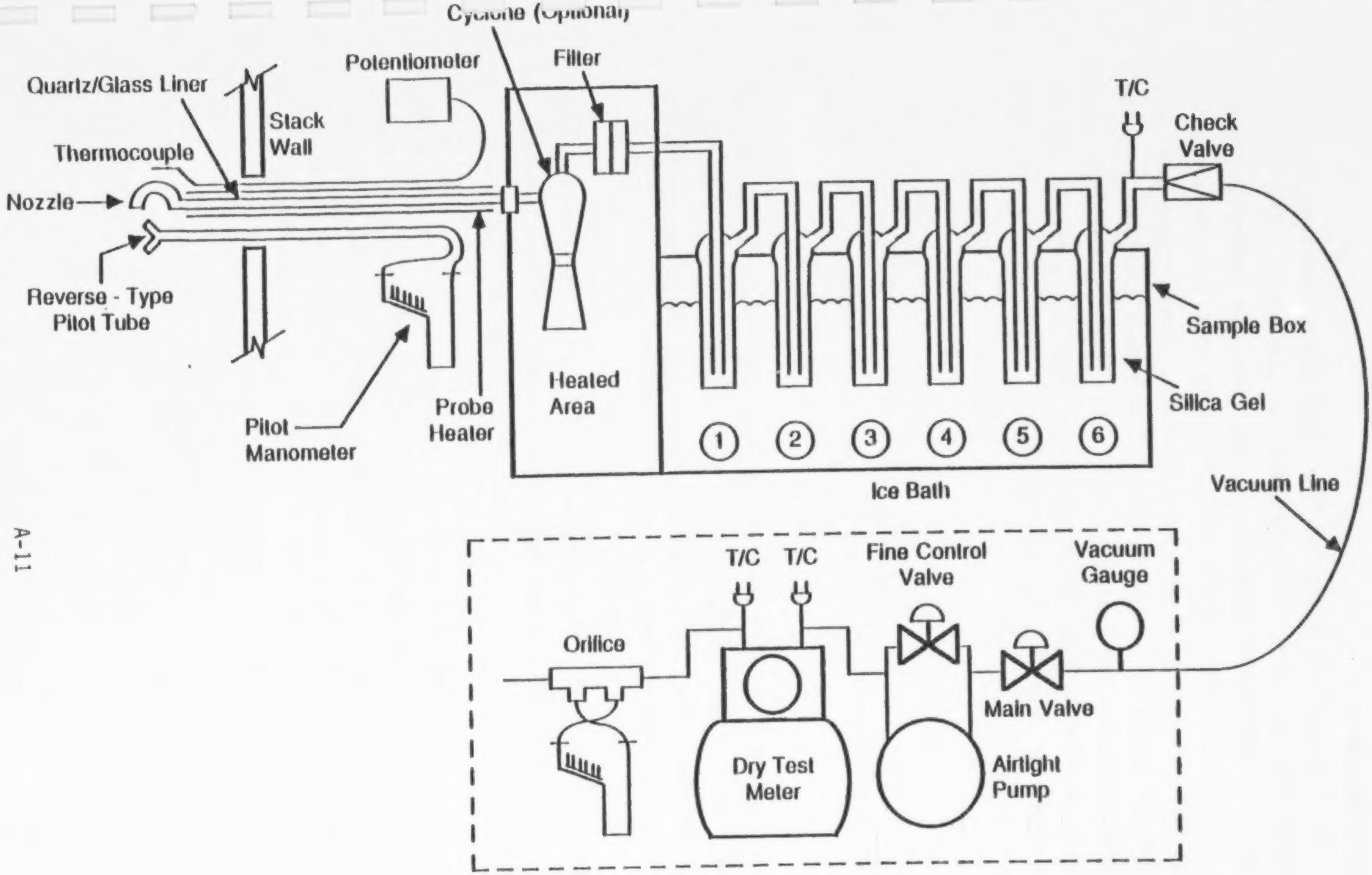
All glass-to-glass connections were made from threaded glass and Teflon® ferrules. A schematic of the train is shown in Figure A-2.

1.2.1.2 Calibration--

The MM5-M equipment was calibrated, checked for proper operation, and cleaned before and after the field test. Calibration procedures are described in the Project Quality Assurance Plan (Section 7).

1.2.1.3 Preparation--

All MM5-M train sample contact surfaces, glassware, rinse bottles (Teflon® or polyethylene), and sample containers (new clear or amber borosilicate glass bottles with Teflon®-lined screw caps) were thoroughly cleaned according to the procedure described in Section 1.1, Process Feed Sampling. No metallic components were used. All train components that were to contain sample gas were sealed with plastic caps immediately after cleaning. During train assembly in the field, all impingers including loaded reagents were tared for moisture determination.


Cyclone (Optional)
Potentiometer
Filter
Quartz/Glass Liner
Stack Wall
Thermocouple
Nozzle
Reverse - Type Pitot Tube
Pitot Manometer
Probe Heater
Heated Area
T/C
Check Valve
Sample Box
Silica Gel
①
②
③
④
⑤
⑥
Ice Bath
Vacuum Line
T/C
T/C
Fine Control Valve
Vacuum Gauge
Orifice
Main Valve
Dry Test Meter
Airtight Pump

① 2L Modified Greenburg-Smith, Empty
② Greenburg-Smith, 100mL 5% HNO_3 and 10% H_2O_2 Soln
③ Greenburg-Smith, 100mL 5% HNO_3 and 10% H_2O_2 Soln
④ Modified Greenburg-Smith, Empty
⑤ Greenburg-Smith, 100mL 0.5N NaOH Soln
⑥ Modified Greenburg-Smith, Silica gel

Figure A-2. Diagram of MM5 train.

1.2.1.4 Sample Recovery--

At the end of a test run after the final leak check, the sampling train was disassembled into two parts, the probe and the sample box. The inlet to the sample box was covered and both ends of the probe were sealed to prevent sample loss and contamination. These components were then transferred to the laboratory at MRI for recovery. At the laboratory, sample components were recovered from the sample box and the nozzle. The sample component from the probe was recovered in a clean laboratory hood. All liquid sample components were transferred to tared bottles and weighed after recovery to verify that no losses occurred during transport to the laboratory. Sample components were recovered as follows:

- Front half acetone rinse--The nozzle, probe liner, cyclone bypass, and the front of the filter holder were rinsed with brushing (nylon bristle brush with Teflon®-coated rod) three times or more until clean.

- Front half 0.1 N nitric acid rinse--The same train components as above were rinsed without brushing three times. These rinses were combined and saved. A final water then acetone rinse was performed, and the water and acetone discarded.

- Filter--The filter was removed with Teflon®-coated forceps and placed and sealed in a glass petri dish along with any loose particulate and filter particles removed with a nylon bristle brush.

- Back half--The first four impingers (condensate and nitric acid/hydrogen peroxide solutions and carryover) were weighed for moisture determination. The contents were transferred to a tared bottle. The impingers, connecting glassware, filter holder back, and the filter support were rinsed with 0.1 N nitric acid into the bottle. The bottle was weighed to determine the sample weight.

- The fifth impinger (caustic) and the sixth impinger (silica gel) were weighed for moisture determinations. Contents of the caustic impinger were archived, and the silica gel was discarded.

The first four sample components (for metals analysis) were stored at ice temperature until analysis. The sample container containing the nitric acid/ hydrogen peroxide solution (back half) was vented (lid loosened to relieve any pressure and retightened) upon receipt at the laboratory.

1.2.2 Total Hexavalent Chromium Mass Loading [MM5-Cr(VI) Train]

The total mass loading of hexavalent chromium was determined by samples extracted from the stack gas using a Modified Method 5-Chromium(VI) [MM5-Cr(VI)] sampling train. The sampling procedure consisted of isokinetic sampling of a volume of the stack gas and impinging the hexavalent chromium in a dilute sodium hydroxide solution. A 0.1 N sodium hydroxide solution was used to preserve the alkalinity of the impinger contents during sampling. This alkalinity was necessary to prevent conversion of hexavalent chromium to trivalent chromium, although excess alkalinity would be detrimental to the analytical effort due to the high salt content. Recent EPA studies of the current state-of-the-art source sampling procedures for hexavalent chromium have shown 50 to 90% conversion of hexavalent chromium in the train during sampling. Therefore, a filter was not used in the train so that the entire sample could be quickly and directly collected in an alkaline medium, allowing for periods up to 30 days in an alkaline solution (pH 8-10) without sample degradation (Chromium Electroplaters Test Report, Entropy Environmentalists, Inc., March 1986; EPA/EMB File No. 86 CEPI). In general, the MM5 sampling procedures parallel those specified in USEPA Methods 1 through 5 in 40 CFR 60. For guidance, the "EPA Draft Method--Determination of Hexavalent Chromium Emissions from Stationary Sources" and the latest available method development information were used to develop the protocol for this test program.

1.2.2.1 Apparatus--

The design of the MM5-Cr(VI) sampling train is based upon the apparatus normally employed in USEPA Method 5, with some modification for these testing requirements. The train components were the same as those for the MM5-M train described in the previous section, except for the elimination of the filter and the change in the impinger sequence and contents which are described as follows:

- The first impinger was a Greenburg-Smith (GBS) with a 2-L capacity to accommodate the collection of condensate from the high moisture gas stream. It contained 200 mL of 0.1 N sodium hydroxide or enough to submerge the impinger stem tip at the start of sampling.

- The second impinger was a GBS with a capacity of 500 mL containing 100 mL of 0.1 N sodium hydroxide.

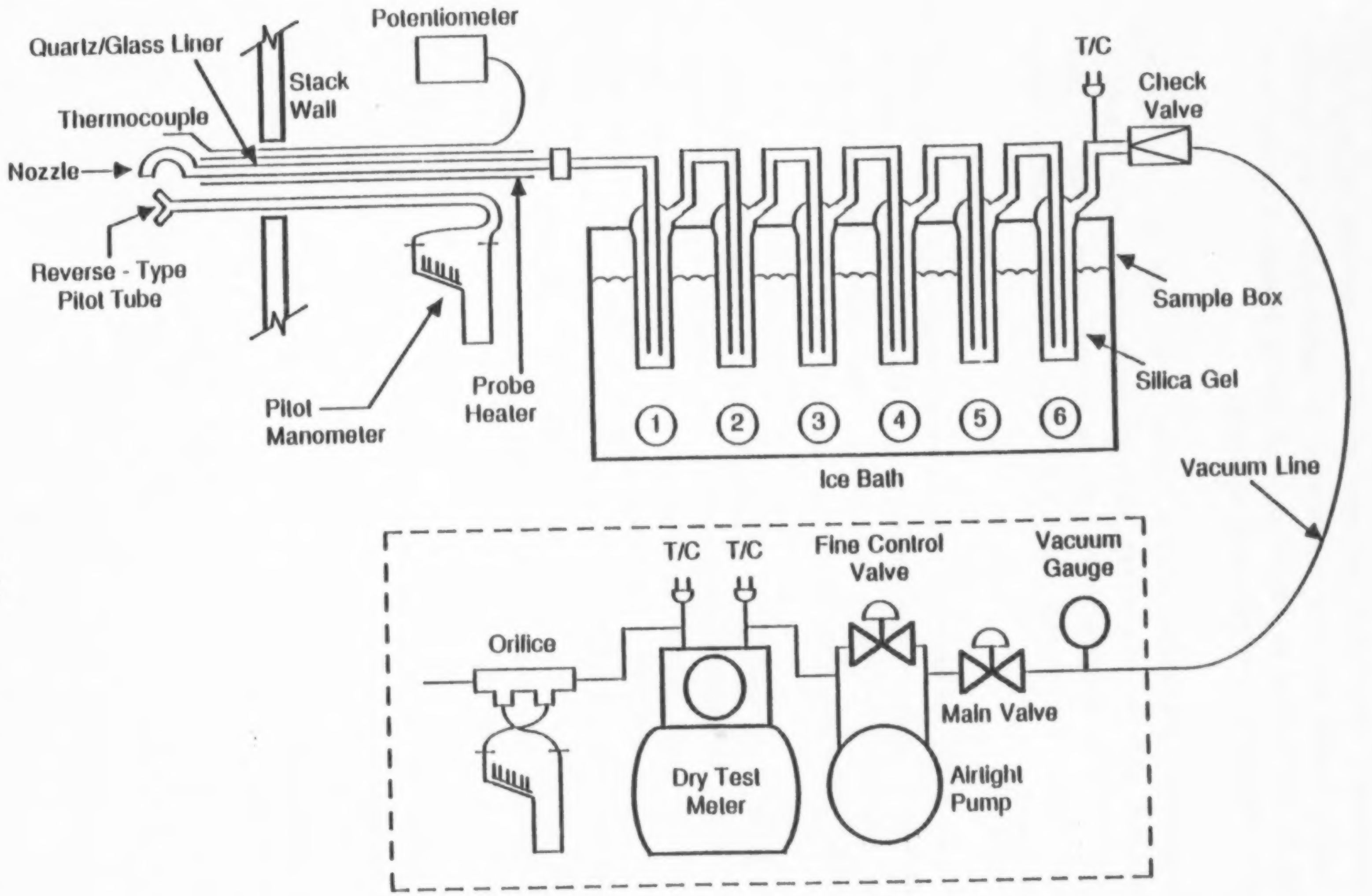
- The third, fourth, and fifth impingers were empty modified GBS to catch any carryover from the second impinger.

- The final modified GBS impinger contained about 200 g of indicating silica gel.

All glass-to-glass connections were made with threaded glass and Teflon® ferrules. A schematic of the train is shown in Figure A-3.

1.2.2.2 Calibration and Preparation--

All calibration procedures and preparation procedures were the same as those for the MM5-M train described in the previous section. Details of calibration procedures are described in the Project Quality Assurance Plan (Section 7).


Potentiometer
Quartz/Glass Liner
Stack Wall
Thermocouple
Nozzle
Reverse - Type Pitot Tube
Pitot Manometer
Probe Heater
T/C
Check Valve
Sample Box
Silica Gel
① ② ③ ④ ⑤ ⑥
Ice Bath
Vacuum Line
T/C
T/C
Fine Control Valve
Vacuum Gauge
Orifice
Dry Test Meter
Main Valve
Airtight Pump

① 2L Modified Greenburg-Smith, 200 mL 0.1N NaOH Soln
② Greenburg-Smith, 100mL 0.1N NaOH Soln
③ Modified Greenburg-Smith, Empty
④ Modified Greenburg-Smith, Empty
⑤ Modified Greenburg-Smith, Empty
⑥ Modified Greenburg-Smith, Silica gel

Figure A-3. Diagram of MM5-Chromium(VI) train.

1.2.2.3 Sample Recovery--

Train disassembly after each run was the same as for the MM5-M train. All liquid sample components were transferred to tared bottles and weighed after recovery to verify that no losses occurred during transport to the laboratory. Sample components were recovered as follows:

- Chromium(VI) train--The nozzle, probe liner, and any connecting glassware back to the first impinger were rinsed, with brushing (nylon bristle brush with Teflon®-coated rod) three times or more until clean. The solvent was 0.1 N sodium hydroxide. These rinses were saved.

- The same train components as above were rinsed with brushing with ASTM Type I reagent water three times. These rinses were combined with the alkaline rinses and saved. The train components were allowed to air dry prior to further sampling.

- The first five impingers (sodium hydroxide and carryover) were weighed for moisture determination. The contents were transferred to a tared bottle which contained all other sample rinses from the train. The impingers and connecting glassware were rinsed and brushed with 0.1 N sodium hydroxide into the bottle, removing all visible residue from the internal surfaces. A final water rinse was performed and added to the sample. The bottle was weighed to determine the net sample weight.

- The silica gel impinger was weighed for moisture determination and the contents disposed.

The first sample component (for hexavalent chromium analysis) was stored at ice temperature until analysis.

1.2.3 Metals (Arsenic, Cadmium, Total Chromium, Lead) Loading by Particle Size Distribution

The loadings of arsenic, cadmium, total chromium, and lead were determined by particle size from samples extracted from the stack gas using a Modified Method 17--Metals (MM17-M) sampling train equipped with an Anderson High Capacity Stack Sampler (HCSS). Sampling was performed at a single point in the gas stream.

The Anderson HCSS is an in-stack, two-stage cascade impactor/cyclone system that separates the particle size distribution into four size fractions (nominally > 10, 5-10, 1-5, and < 1 μm). In general, the MM17 sampling procedures parallel those specified in USEPA Methods 1, 2, 3, 4, and 17 as published in 40 CFR 60. All procedures were in accordance with the "Operating Manual for Anderson Samplers, Inc., HCSS, Heavy Grain Loading Impactor, Particle Sizing Stack Samplers," January 1, 1980, except that an extractive sampling probe was used.

Samples were extracted through a heated borosilicate glass probe liner (nominally maintained 10°F above the stack temperature) and a nickel nozzle. Quartz nozzles could not be used as the available nozzles were too large for isokinetic sampling at the desired rates. The best available choice was nickel nozzles of 0.375-in inside diameter which allowed isokinetic sampling rates of 25% to 28%.

To minimize the level of background metals, a 5.5-in diameter Whatman QM-A quartz fiber filter housed in a Teflon®-lined stainless steel holder was attached to the outlet of the HCSS. This was used instead of the glass fiber thimble normally employed with the HCSS. The thimbles were suspected to have a high metals background level.

The internal surfaces of the HCSS were thoroughly cleaned before each use by scrubbing and brushing with hot soapy water, rinsing with hot tap water, rinsing with deionized distilled water, rinsing with acetone, and finally drying in a heated oven. Samples were recovered by rinsing the surfaces with acetone. Brushing was not done because of the potential for added contamination. All surfaces were oxidized and some surfaces were slightly pitted.

Initially, the thimble holder was cleaned with hydrochloric acid to remove oxides and accumulated scale. This was only done once before the first sampling run. It was not known which condition would provide the least contamination under sampling exposure, bare metal, or an oxidized surface. After the first run, this surface was again oxidized and scaled. The brown coloration of some of the rinses and the visually observed sizes of some of the recovered particulate matter indicate a potentially high degree of contamination from the oxidized stainless steel surfaces of the HCSS.

1.2.4 Diluent, Carbon Dioxide, and Oxygen (M3 Train)

The carbon dioxide and oxygen content of the stack gas was determined from integrated (continuous constant sampling rate) samples extracted from the stack gas using a Method 3 (M3) integrated gas sampling train. The sampling procedure consisted of extracting a sample at a constant rate into a leak-free Mylar bag which was analyzed immediately after each sampling run for percent carbon dioxide and percent oxygen by volume on a dry-basis using an Orsat gas analyzer. Samples were extracted concurrently with other samples requiring determination of gas molecular weight and pollutant concentration corrected to standard diluent concentrations (e.g., corrected to 7% oxygen). The M3 sampling and analytical procedures followed those specified in U.S. EPA Methods 1 and 3 in 40 CFR 60 for integrated multipoint sampling.

1.2.4.1 Apparatus--

The probe was an unheated stainless steel tube attached to the probe sheath of the MM5-M, M5, and MM5 sampling train when each of those trains was used. Diluent data from the MM5-M train was used for computing the applicable MM5-Cr(VI) results since both trains were operated simultaneously. The inlet probe tip was positioned to extract the sample within 3 in of the respective M5 or MM5 sampling nozzle. Moisture and particulate matter were removed with a filter coalescer and a water-cooled condensing coil. Constant flow rate was maintained by using a calibrated rotameter. A schematic of the sampling train is shown in Figure A-4.

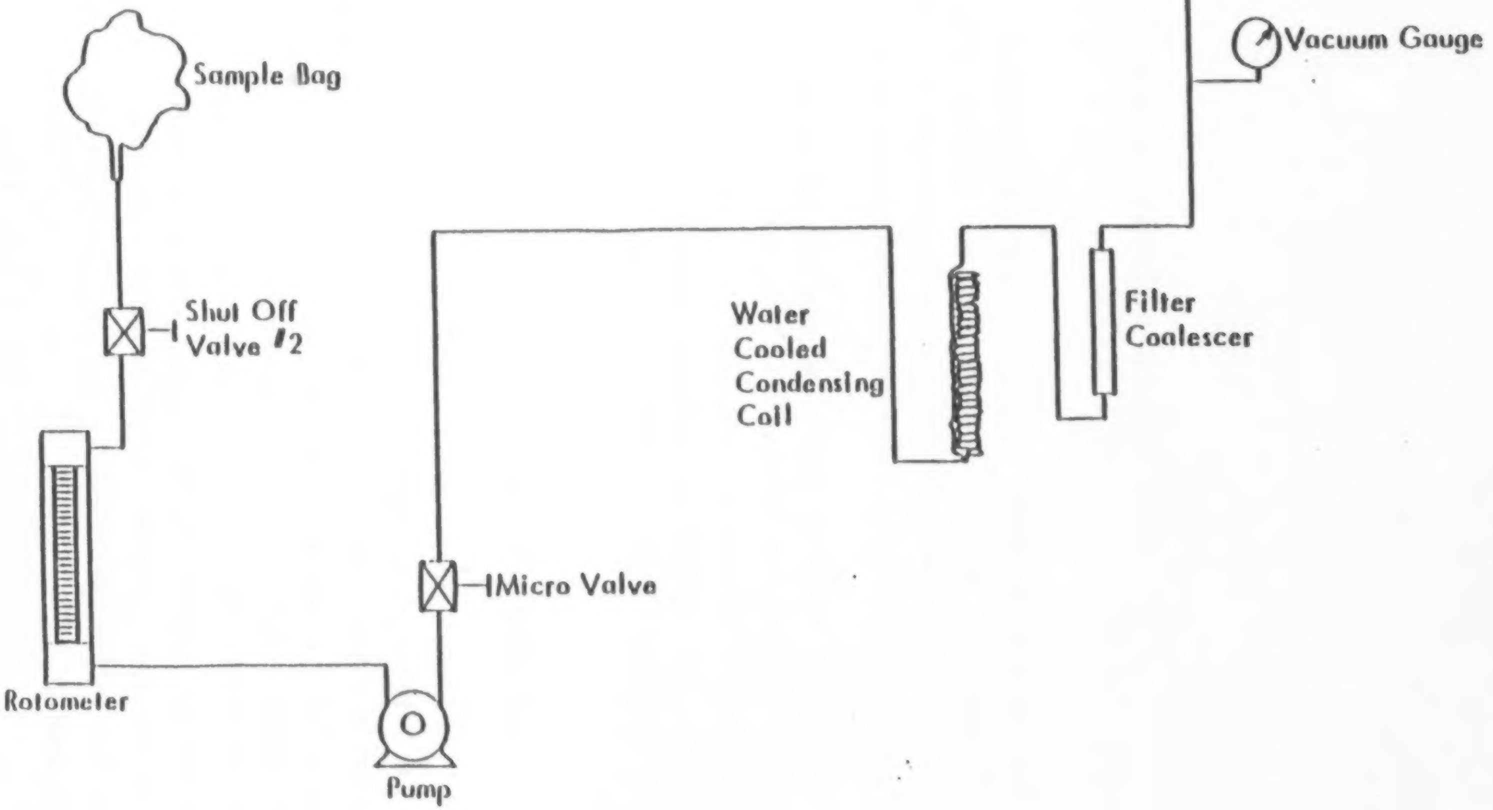

Stainless Steel Probe
Shut Off Valve #1
Vacuum Gauge
Sample Bag
Shut Off Valve #2
Water Cooled Condensing Coil
Filter Coalescer
Micro Valve
Rotometer
Pump

Figure A-4. Method 3 integrated gas sampling train.

SECTION 2.0

TOTAL ORGANICS MEASUREMENT METHODS

This section addresses organic emissions measurements from the stack. A recently developed method for measuring total organic emissions was used and compared with measurements of total organic emissions by a heated total hydrocarbon (THC) analyzer with flame ionization detector (FID).

The methods are from several sources including those given in the recent draft paper ("Screening Approach for Principal Organic Hazardous Constituents and Products of Incomplete Combustion," L. Johnson et al, presented at APCA, June 1988), the supporting Southern Research Institute (SRI) draft report ("POHCs and PICs Screening Protocol"), and the Level I Source Assessment Manual.

2.1 VOLATILE ORGANIC METHODS

An integrated gas sampling system using Tedlar bags was used to extract stack gas samples at a constant sampling rate from a single point in the stack for volatile organic analysis. A schematic of the sampling apparatus is shown in Figure A-5. A special water condensate trap with a septum port was used to permit direct withdrawal of the condensate for analysis. The quantity of collected condensate for each sample was determined gravimetrically. The volume of the dry gas sampled was determined with a calibrated rotameter between the trap and the bag. A blank bag filled with prepurified nitrogen was placed in the bag box before each sampling and was analyzed along with the bag containing the sample.

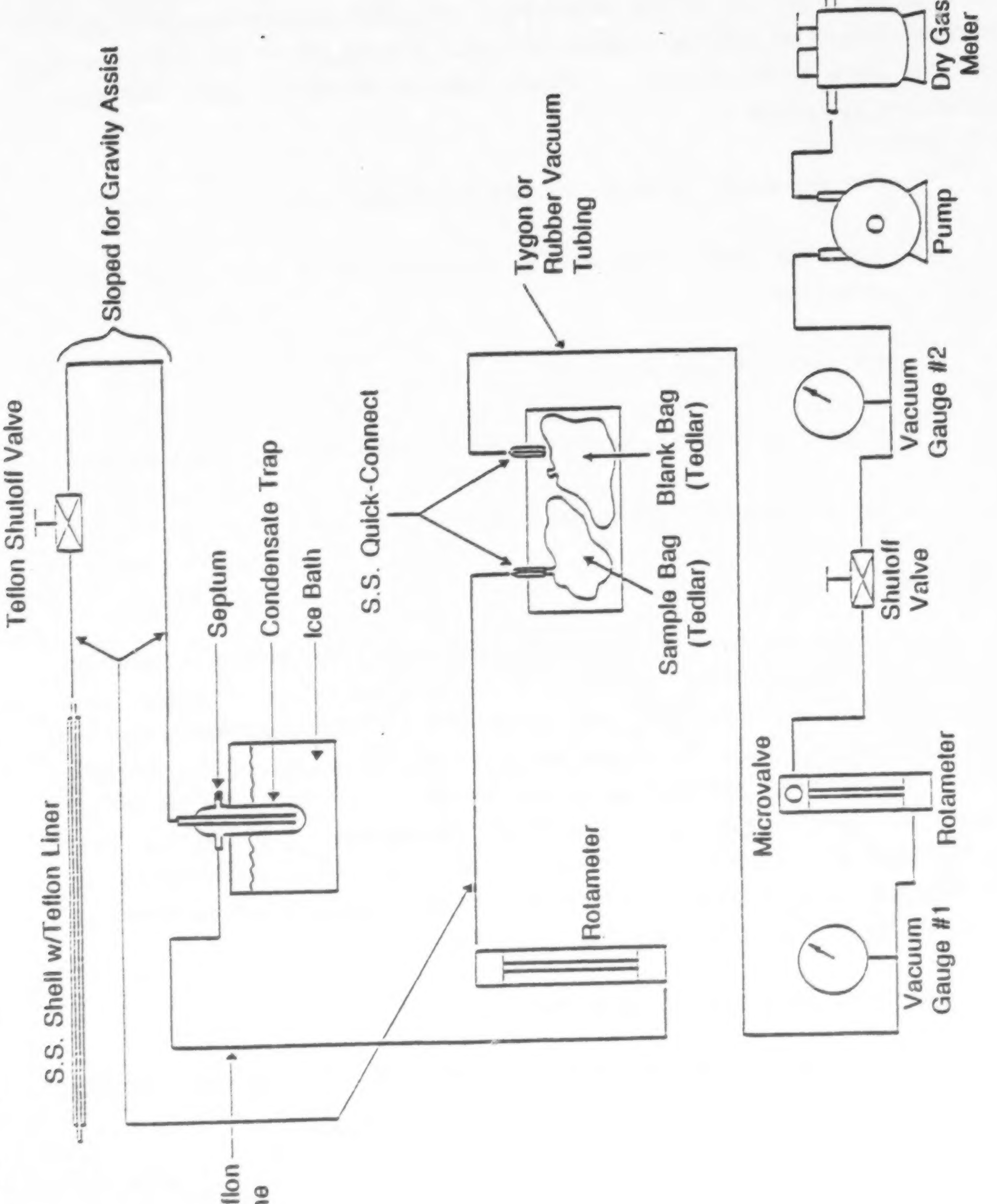

S.S. Shell w/Teflon Liner
Teflon Shutoff Valve
Sloped for Gravity Assist
Septum
Condensate Trap
Ice Bath
S.S. Quick-Connect
Teflon Line
Rotameter
Tygon or Rubber Vacuum Tubing
Sample Bag (Tedlar)
Blank Bag (Tedlar)
Vacuum Gauge #1
Microvalve
Rotameter
Shutoff Valve
Vacuum Gauge #2
Pump
Dry Gas Meter

Figure A-5. Integrated volatile organics sampling train.

2.2 SEMIVOLATILE/NONVOLATILE ORGANIC METHODS

The MM5 train uses SW-846 Method 0010, September 1986 version, with 50:50 methanol/methylene chloride recovery solvent. A schematic of the MM5 sampling train is shown in Figure A-6. A 180-min sampling period was used. Modifications were as follows:

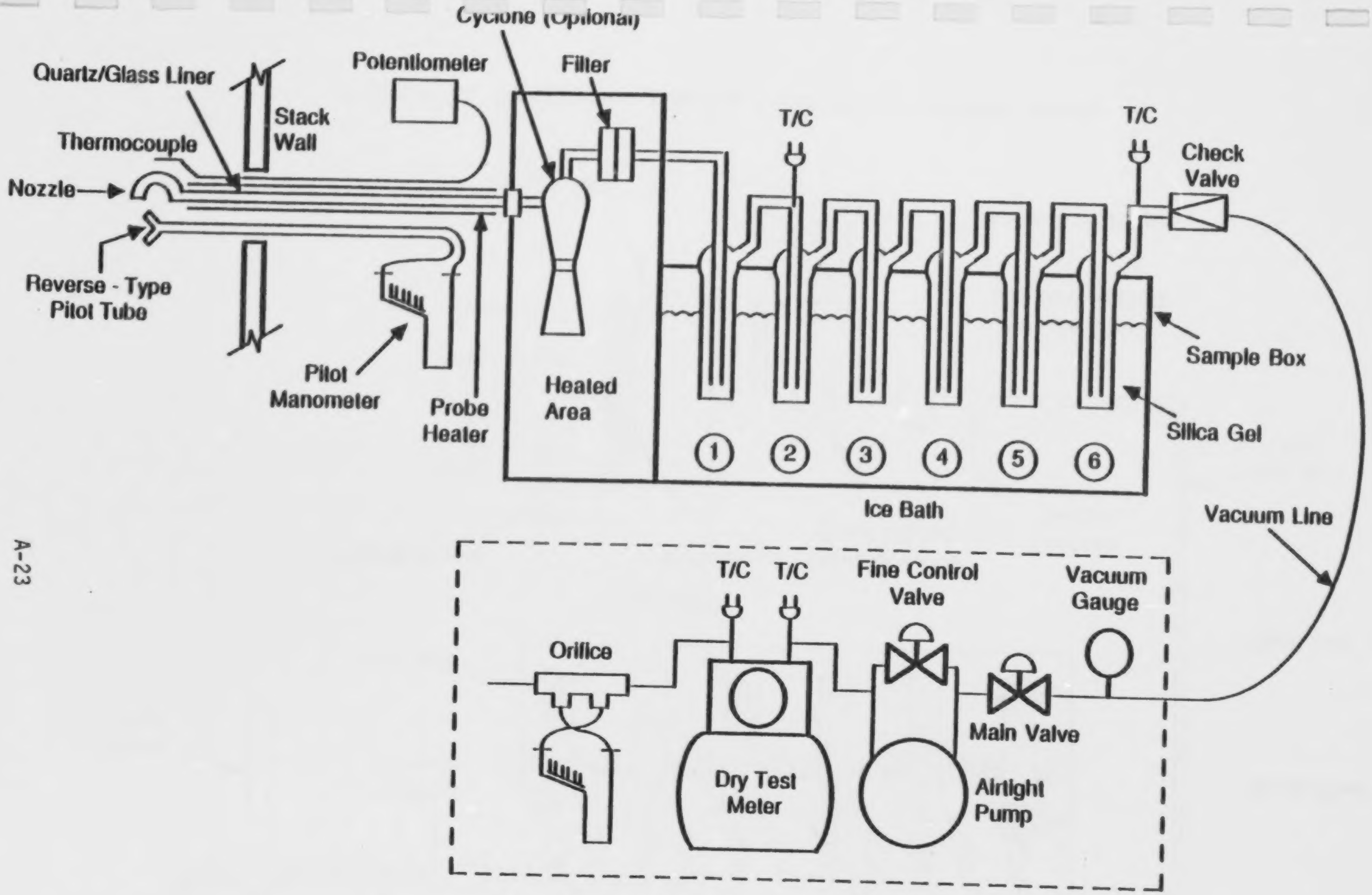
- The MRI design condenser and XAD module were used.
- Stainless steel probe nozzles and borosilicate glass probe liners were used.
- The third impinger was dry.
- Borosilicate filters were used without weighing to constant weight.
- The target sample volume was 3 dscm.

2.3 FORMALDEHYDE

Sampling and analysis was performed according to the procedure given by K. Kuwata, M. Uebori, and Y. Yamasaki, "Determination of Aliphatic and Aromatic Aldehydes in Polluted Airs as Their 2,4-Dinitrophenylhydrazones by High Performance Liquid Chromatography," *J. Chromatogr. Sci.*, 17, 264-268, 1979. The train was operated as an EPA Method 6 train but with two midget fritted impingers containing 10 mL each of DNPH reagent. The sampling train was operated at 0.5 L/min for the full 180-min test period. A schematic of the sampling train is shown in Figure A-7. Sample recovery was performed at MRI according to the reference method.

2.4 TOTAL HYDROCARBON MONITORING METHODS

Total hydrocarbons (heated sample line)--EPA Method 25A was used with the following changes:


Cyclone (Optional)
Quartz/Glass Liner
Potentiometer
Filter
Stack Wall
Thermocouple
Nozzle
Reverse - Type Pitot Tube
Pitot Manometer
Probe Heater
Heated Area
T/C
T/C
Check Valve
Sample Box
Silica Gel
1
2
3
4
5
6
Ice Bath
Vacuum Line
T/C
T/C
Fine Control Valve
Vacuum Gauge
Orifice
Main Valve
Dry Test Meter
Airtight Pump

① Condenser with Ice Water Jacket
② XAD Resin Cartridge with Ice Water Jacket, 70 g of XAD
③ 2L Modified Greenburg-Smith, 100mL of Double Distilled in Glass H_2O
④ Greenburg-Smith, 100mL of Double Distilled in Glass H_2O
⑤ Modified Greenburg-Smith, Empty
⑥ Modified Greenburg-Smith, SiO_2

Figure A-6. Modified Method 5 (MM5) semivolatile organics sampling train.

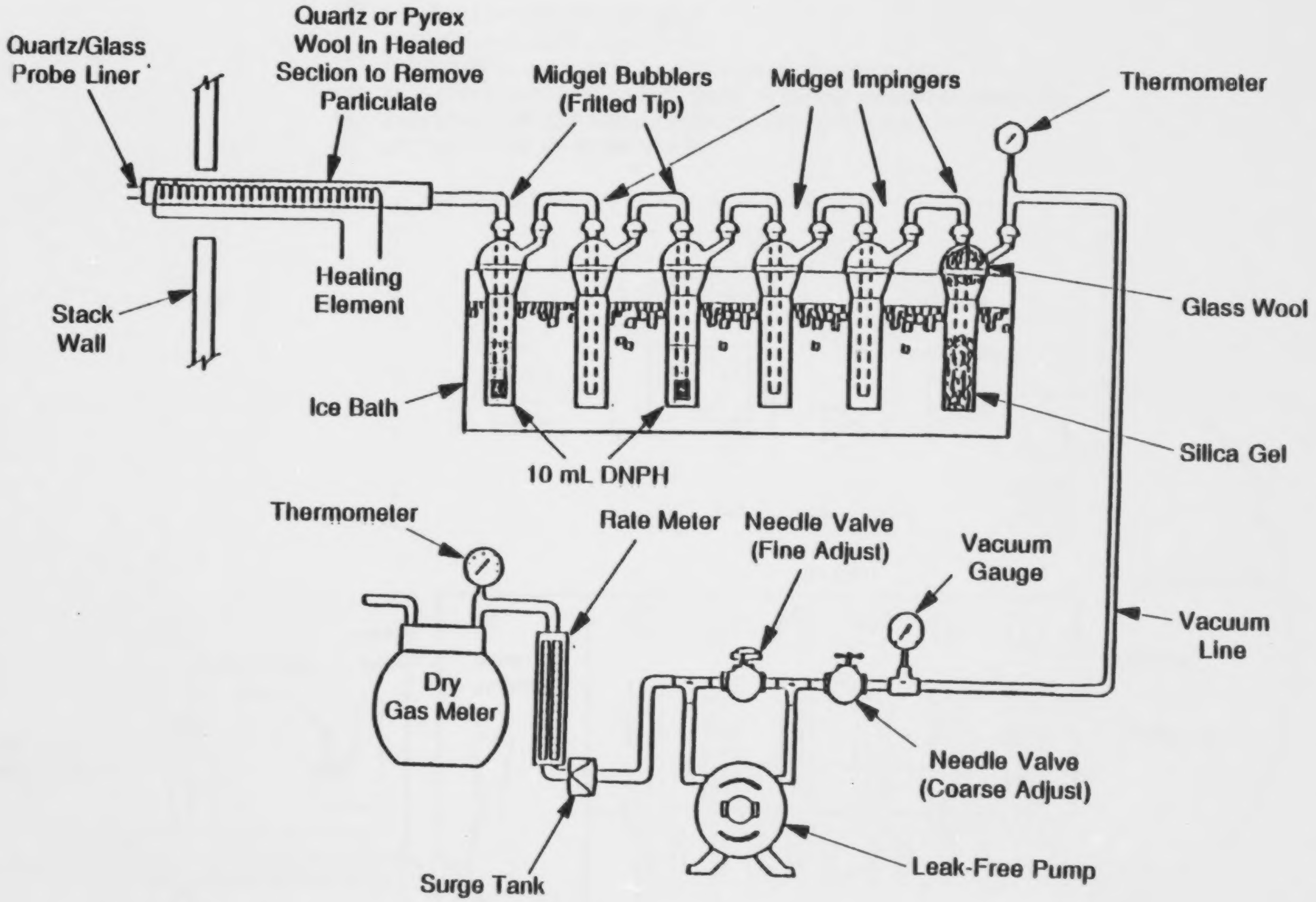

Quartz/Glass Probe Liner
Quartz or Pyrex Wool in Heated Section to Remove Particulate
Midget Bubblers (Fritted Tip)
Midget Impingers
Thermometer
Stack Wall
Heating Element
Glass Wool
Ice Bath
Silica Gel
10 mL DNPH
Thermometer
Rate Meter
Needle Valve (Fine Adjust)
Vacuum Gauge
Vacuum Line
Dry Gas Meter
Needle Valve (Coarse Adjust)
Leak-Free Pump
Surge Tank

Figure A-7. Formaldehyde sampling train for wet scrubber stacks.

- The entire sample system from probe to detector was heated to 150°C.

- A Beckman 402 THC analyzer was used.

- The calibration gas was propane.

- EPA Protocol 1 cylinder standards of 5, 10, 20, 50, and 100 ppm propane in nitrogen were available; the three cylinders which best covered the sample concentration were used.

Total hydrocarbons (unheated line)--EPA Method 25A was used with the following changes:

- An ice-cooled water knockout trap removed condensibles.

- An unheated Teflon sample line conducted the sample through a stainless steel pump to an FID.

- The calibration gas was propane.

- EPA Protocol 1 cylinder standards of 5, 10, 20, 50, and 100 ppm propane in nitrogen were available; the three cylinders which best cover the sample concentration were used.

APPENDIX A-2

ANALYTICAL PROCEDURES

SECTION 1.0

ANALYTICAL PROCEDURES FOR METALS AND PARTICULATE

1.1 PROCESS FEED ANALYSIS

Organic liquid wastes, aqueous liquid wastes, and scrubber waters were all analyzed for metals content (As, Cd, Cr, Pb) according to the methods outlined in Section 1.2.1.

Organic liquid wastes and aqueous wastes were analyzed for ash content by Galbraith Laboratories. ASTM Method D482-80 was used as the reference method.

1.2 METALS AND PARTICULATE ANALYSIS

1.2.1 Metals Analysis

The analytical procedures for metals and hexavalent chromium were based, to the extent possible, on published EPA methods. The determination of the following metals was performed by inductively coupled (argon) plasma atomic emission spectrometry (ICP-AES), graphite furnace atomic absorption spectrometry (GFAAS), or visible spectrophotometry: arsenic, cadmium, total chromium, lead, and hexavalent chromium.

The following samples were submitted for metals analysis:

Sample 1--Organic liquid waste
Sample 2--Aqueous waste
Sample 3--Quench makeup water (city)
Sample 4--Scrubber makeup water
Sample 5a--Scrubber effluent water--Cr(VI) determination

Sample 5b--Scrubber effluent water--total metals determination
Sample 6a--Scrubber alkali water--Cr(VI) determination
Sample 6b--Scrubber alkali water--total metals determination

In addition, the following portions of the sampling trains were included for analysis for metals:

Sample 7(a, b, c)--Probe rinse [acetone (a) and acid (b)] and filter (c)--MM5 train
Sample 8--Impinger solutions and rinses--MM5 train
Sample 9--Impinger solutions and rinses--Cr(VI) train
Sample 10--Total metals impactor particulate catch (final filter)--< 1 µm
Sample 11--Total metals impactor particulate catch (third stage)--1-5 µm
Sample 12--Total metals impactor particulate catch (second stage)--5-10 µm
Sample 13--Total metals impactor particulate catch (first stage)--> 10 µm

Sample 1 was prepared for ICP-AES analysis by dissolution in xylenes according to Method 3040 of SW-846.

Samples 2, 3, 4, 5b, 6b, and 8 (after reduction to less than 50 mL by heating) were digested according to the atomic absorption portion of Method 3050 for subsequent analysis of arsenic, cadmium, total chromium, and lead. Following desiccation and weighing for particulate matter, Samples 7(a, b, c) (combined) (MM5 train filter) and 10-13 (impactor stages) were prepared for analysis by digestion with HF and HNO_3 in microwave PRVs as described in the EPA/EMB Draft Metals Protocol.

Samples 5a, 6a, and 9 were digested by the alkaline procedure described in the paper by Butler et al. The digestate from this alkaline digestion was analyzed according to the procedure in that paper.

Blank samples including filters and impinger contents were digested according to the atomic absorption portion of the Method 3050 digestion or HF/HNO_3 digestion.

Following Method 3050 digestion, HF/HNO_3 digestion, or Method 3040 dissolution, the resulting digested samples were analyzed by ICP-AES according to Method 6010 of SW-846 (third edition). The analytes were arsenic, cadmium, chromium, and lead depending upon the analytes of interest for each sample. If a sample result was less than five times the detection limit by Method 6010 for any analyte, that analyte was analyzed by the appropriate series 7000 Method of SW-846 for that analyte using GFAAS. Any samples prepared for analysis by Method 3040 were not analyzed by GFAAS.

After a total of three attempts were made to analyze the scrubber effluent and stack gas samples for hexavalent chromium, no results were obtained. The initial attempt consisted of alkaline digestion of the samples followed by coprecipitation with lead sulfate. The resulting precipitate was digested with nitric acid and hydrogen peroxide. There was no yellow precipitate noted for samples which were spiked either before the alkaline digestion or before the coprecipitation step. After the nitric acid digestion, those samples which were high spikes were analyzed on the ICAP, where it was found that there was no recovery of the spikes. It was suspected that the problem may have originated in the alkaline digestion as past experience indicated problems could occur. The samples were reprecipitated without the alkaline digestion. A reference spike, or a sample which consisted only of water and spike, was precipitated with the samples. The reference spike returned a yellow precipitate while no other sample did, including spiked samples. The precipitates were again digested with nitric acid and hydrogen peroxide and the high spikes and the reference spike analyzed by ICAP. Again the spiked samples showed no recovery but the reference spike was recovered at 114%. This indicated that hexavalent chromium was likely being reduced by the samples themselves rather than the procedure not working properly.

Finally, the analysis as described in the paper by F. E. Butler, J. E. Knoll, and M. R. Midgett, *Journal of the Air Pollution Control Association*, 36(5), 581-584, which involved chelation and spectrophotometric determination after alkaline digestion was tried. The detection limit was much higher for this procedure and the samples were spiked with higher levels accordingly. The analysis resulted in spike recoveries of approximately 65-70% for the stack gas samples, but the spikes still showed no recovery for the scrubber effluent samples. It had been speculated earlier by personnel from EPA that the SO_2 content of the stack gas may affect the hexavalent chromium results. This data indicated that something along these lines was taking place as one would expect more species such as SO_2 to be absorbed into the scrubber effluent.

1.2.2 Particle Size Analysis

After sampling, the four size fractions were desiccated, weighed, and then prepared for metals analysis according to SW-846 procedures. The four particle size fractions ranged from 2 to 65 mg each, with most of the material being recovered from the backup filter (fourth stage). The individual fractions were then analyzed separately for metals content as per Section 1.2.1.

1.2.3 Particulate Loading Analysis

Particulate analysis was performed gravimetrically according to EPA Method 5, 40 CFR 60. Filter weights and beaker weights are presented in Appendix B-2. Following gravimetric analysis, components were analyzed for metals content as per Section 1.2.1.

SECTION 2.0

ANALYTICAL PROCEDURES FOR ORGANIC COMPOUNDS

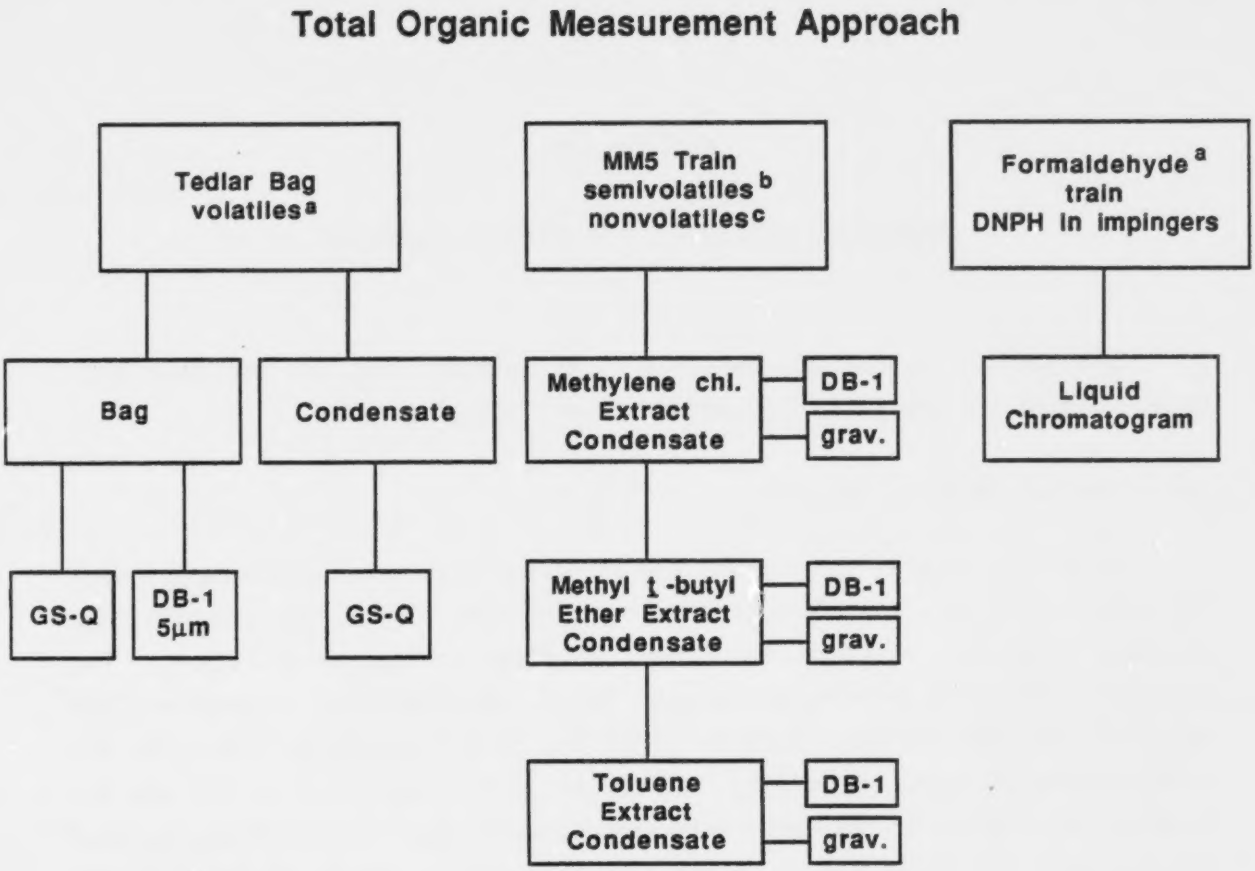
This section summarizes the analytical methods used for the test program. Figure A-8 and Table A-2 depict the analytical scheme.

2.1 VOLATILE ORGANICS ANALYSIS

Tedlar bag samples and blanks, and the associated water condensates, were analyzed by GC/FID within 24 h of sample collection. The GC was a Varian 2400 equipped with two injection ports and two flame ionization detectors. The protocol (*IERL-RTP Procedures Manual: Level 1 Environmental Assessment*, 2nd Edition, EPA-600/7-78-201, October 1978, pp. 55-61) suggested 1-mL gas and 1-µL condensate injection volumes. Actual GC injections of 0.5 mL for the gas samples and 0.5 µL for the condensate samples were required to achieve maximum resolution. See Table A-3 for parameters involved in the GC analyses of the volatile samples.

For each type of volatile analysis on the different columns, appropriate calibration curves were established and their linearity verified by calculating the correlation coefficient (r) for the regression lines described by the area responses of the standard peaks of interest. In all cases, the r value was greater than the required 0.97; thus the calibration curves were assumed to be linear.

Each day of analysis, initial daily check standards (the high concentration standards) were run before each type of sample analysis on the different columns. Peak areas were compared with the average area of the appropriate peak from the standard curve.


Total Organic Measurement Approach

Tedlar Bag volatiles[a]
MM5 Train semivolatiles[b] nonvolatiles[c]
Formaldehyde[a] train DNPH in impingers
Bag
Condensate
Methylene chl. Extract Condensate
DB-1
grav.
Liquid Chromatogram
GS-Q
DB-1 5μm
GS-Q
Methyl t-butyl Ether Extract Condensate
DB-1
grav.
Toluene Extract Condensate
DB-1
grav.

a = Volatiles (C1-C7) = formaldehyde + bag (GS-Q & DB-1, 5μm) + Cond. (GS-Q)
Bag DB-1 used for total, GS-Q for C1-C2

b = Semi-volatiles (C7-C17) = MeCl (DB-1, 1.5μm) + ether (DB-1, 1.5μm) + toluene (DB-1, 1.5μm)
Total = Extract + Condensate

c = Non-volatiles (C17+) = MeCl (grav.) + ether (grav.) + toluene (grav.)

The extraction sequence is methylene chloride, ether, and toluene.
Each extract is analyzed separately.

Figure A-8. Total organic measurement approach.

TABLE A-2. SAMPLING AND ANALYSIS MATRIX FOR TOTAL ORGANICS

Sample fraction	Sampling method	Analytical method
Volatiles (C_1-C_7) b.p. < 100°C	Tedlar bag	Field GC/FID 30-m GS-Q megabore 30-m DB-1, 5-µm megabore
Formaldehyde (FID has no response)	Impinger train w/DNPH	High performance liquid chromatography (HPLC)
Semivolatiles (C_7-C_{17}) b.p. 100-300°C	MM5 train	GC/FID of methylene chloride, methyl *t*-butyl ether, and toluene extracts (condensate analyzed as a separate fraction)
Nonvolatile (> C_{17}) b.p. ≥ 300°C	MM5 train	Gravimetric analysis of methylene chloride, methyl *t*-butyl ether, and toluene extracts (condensate analyzed as a separate fraction)

TABLE A-3. ANALYSIS OF VOLATILE ORGANICS

Species of interest	Sensitivity	Column	Temperature and conditions	Detector
C_1-C_2 (Bag fraction)	0.1 ppm	30-m GS-Q megabore	Helium carrier at 5-7 mL/min with helium makeup gas at 20 mL/min. Detector temperature = 205°C Injector temperature = 210°C Temperature program = 40°C to 120°C at 6°C/min	FID
C_3-C_7 (Bag fraction)	0.1 ppm	30-m DB-1 5.0-µm megabore	Helium carrier at 5-7 mL/min with helium makeup gas at 20 mL/min. Detector temperature = 205°C Injector temperature = 187°C Temperature program = 40°C Isothermal	FID
C_1-C_7	0.1 ppm	30-m GS-Q megabore	Helium carrier at 5-7 mL/min with helium makeup gas at 20 mL/min. Detector temperature = 205°C Injector temperature = 210°C Long temperature program = 40°-182°C at 6°C/min Short temperature program = 125°C, hold 3 min, to 150°C at 12°C/min, hold until C_7 peak is eluted.	FID

If the area of any peak was not within ±15% of the standard peak, the check standard was reanalyzed until there was ±15% agreement between the check standard and standard curve or between duplicate runs of the daily check standard. When total analysis time for a particular type of analysis was greater than 1 h, a final check standard was run. Peak areas were compared with the initial check standard(s) as well as with the standard curve.

2.1.1 C_1-C_2

Clean separation of methane, ethane, ethylene, and acetylene was achieved on the 30-m GS-Q megabore column. Calibration of the GC for these compounds was accomplished by creating a five-point calibration curve (area response versus concentration) using Scott Specialty Gases Mixture No. 54, C_1-C_4 hydrocarbons at approximately 20 ppm each. Standards in the 4, 8, 12, and 16 ppm range were prepared by diluting the 20-ppm standard with ultrahigh purity nitrogen in a 0.5-mL gastight Pressure-Lok syringe. It was determined that the syringe had an estimated 0.02-mL dead volume associated with the needle. Concentrations of the standards were corrected for this dead volume. The dilution procedure was very reproducible with peak areas of duplicate injections falling within the ±15% criteria and correlation coefficients of 0.98 and greater for each compound.

Difficulties were encountered in separating the methane peak from the FID response caused by air. The integrator program was able to separate to some degree the two peaks at most standard concentration levels. Separation in the 20-ppm concentration standard was achieved for only one of two injections used to prepare the calibration curve. The correlation coefficient for the methane regression line was 0.98, still within the quality control criteria. However, the regression line had a large y-intercept that could not be corrected further; hence the results for methane may be overstated.

Individual concentrations of methane, ethane, ethylene, and acetylene, as well as total chromatographable organics (TCO) in the C_1-C_2 window, were calculated as propane (C_3). The average response factors for C_3 from the daily initial and final check standards for each day were used to calculate the concentrations found in samples analyzed that particular day. Results were reported in ppm propane. Individual concentrations of methane, ethane, ethylene, and acetylene were also converted to concentrations of ppm methane for the methane peak, ppm ethane for the ethane peak, and so on. From the calibration curve, ratios of the slope of the propane regression line to the slopes of the other regression lines gave multiplying factors by which the individual concentrations as ppm propane could be converted to the individual concentrations as ppm methane, ppm ethane, and so on. As discussed above, methane concentrations may be overstated.

2.1.2 C_3-C_7

Total C_3-C_7 in the Tedlar bag fraction was obtained from the 30-m DB-1 5.0-μ megabore column. A five-point calibration curve was set up using Scott Specialty Gases Mixture No. 243, C_1-C_7 hydrocarbons at approximately 15 ppm each. In-syringe dilutions of the 15-ppm standard gave standards in the 3-, 6-, 9-, and 12-ppm range. Again, this dilution method was quite reproducible with duplicate injections falling within ±15% of each other and correlation coefficients of greater than 0.99 for each compound. As discussed earlier, standard concentrations were corrected for the syringe dead volume. In that C_1 and C_2 could not be separated on the DB-1 5.0-μ column at the lowest reliable temperature on the GC, only data in the C_3-C_7 window were obtained from this column. As with the C_1-C_2 analysis, TCO in the C_3-C_7 window was calculated as propane. Average response factors for C_3 from daily initial and final check standards were used to calculate the concentrations found in the samples. Results were reported in ppm propane.

2.1.3 C_1-C_7 (Condensate)

The 30-m GS-Q column was used for the analysis of total C_1-C_7 in the condensate fraction. During preliminary work, complete separation of the C_1-C_7 *n*-paraffins had been achieved with this column using a relatively long temperature program. Problems with the higher boiling compounds and the reproducibility of their area responses from duplicate injections developed just before sample analyses started on Run 5. The initial five-point calibration curve with the 15 ppm C_1-C_7 hydrocarbon gas mixture and dilutions thereof showed that significant amounts of the C_5, C_6, and C_7 *n*-alkanes were being lost. Because the volatile sample holding time was 24 h or less, sample analyses had to continue while an acceptable five-point calibration curve was being established. Since the C_1 to C_4 components in the standards and all peaks in the samples were stable, the C_3 standard peak was used to monitor the daily standards.

Initially it was thought that the high-temperatures near the end of the temperature program were causing leaks in the GC system which preferentially affected the higher boiling standard compounds. To investigate this potential high-temperature leak phenomenon, a shorter program with a lower final temperature was developed. This program did not resolve the C_1 and C_2 peaks; however, the other hydrocarbons remained resolved.

The shorter temperature program was continued for the analyses of the condensates from Runs 6-10. The condensate samples from Runs 6-9 were analyzed before a calibration curve using the shorter temperature program had been established. However, the daily check standard C_3 peak remained within the ±15% criteria.

It was then determined that purging the standard gas cylinder for approximately 1 min resulted in a representative aliquot of the standard mix and more reproducible results--evidently the C_5, C_6, and C_7 compounds were being retained by materials in the cylinder regulator. An acceptable five-point calibration curve was established before analysis of the condensate sample from Run 10.

Analysis of Milli-Q water on the 30-m GS-Q with both the long and short temperature programs used to analyze the condensates revealed a large water peak response at 48 s in the shorter program and 60 s in the longer program. Since this peak was present in both the Milli-Q water and the samples, it was excluded from the TCO calculations. TCO in the C_1-C_7 window of the condensate samples was also reported in ppm propane.

2.2 SEMIVOLATILE ORGANICS ANALYSIS

Semivolatile and nonvolatile sample extraction was performed according to the procedure given in "POHCs and PICs Screening Protocol" (Southern Research Institute), Section III.C., with the following changes. All solvent rinses, filter, and XAD were combined and extracted with methylene chloride, again with methyl *t*-butyl ether, and a third time with toluene. Extraction blanks were analyzed for all three solvents. No surrogate spike was used.

The back-half rinses and the condensates were extracted in a separatory funnel three times with 60-mL portions of each solvent. The complete series of extractions were made first at a pH of 3 and then again at a pH of 11. The extracts from the back-half rinses were then combined with the extract from the rest of the sample train. The condensate extracts were analyzed as separate samples. Due to the large volume of water in the condensates, only the blanks and Run 8 were extracted completely, 1-L portions of the condensate from the other samples were extracted, and all analysis results are corrected to the ratio of the full volume to the extracted volume.

Analysis of the methylene chloride, *t*-butyl methyl ether, and toluene extracts of the MM5 train was accomplished by following the procedure outlined in Section III.D. of "POHCs and PICs Screening Protocol" with the following modifications.

Standards and extracts were analyzed by GC/FID (Varian Model 2400) with the following operating conditions:

Column: 30-m DB-1 1.5-µ megabore column
Temperature program: 40°C to 200°C at 8°C/min
Carrier gas: 10 mL/min helium
Makeup gas: 20 mL/min helium
Injector temperature: 240°C
Detector: FID at 220°C

Injection volumes for the standards, the methylene chloride, and the *t*-butyl methyl ether extracts were 0.8 µL while 0.7 µL was injected for toluene samples. Results were corrected for the differences in injection volume. Train condensates were also analyzed.

The standard stock solution for the semivolatiles was prepared according to the procedure. However, working standards were not prepared by serial dilution--rather, each different concentration level was prepared directly from the stock solution.

A five-point calibration curve for semivolatile analysis was set up using standards of 6-, 12-, 18-, 25-, and 30-µg/mL concentrations. Linearity over the range of standards was verified by calculating the linear regression lines and correlation coefficients for the three quantitation peaks: C_{10}, C_{12}, and C_{14}. Correlation coefficients were 0.9989, 0.9993, and 0.9988, respectively. These values were greater than the required 0.97 in the protocol.

The requirements for precision and accuracy in the protocol were followed with some qualification.

2.2.1 Standards

Each day of analysis, an initial daily check standard (the high concentration standard) was run prior to analyzing samples. Peak areas were compared with the average area of the appropriate peak from the standard curve. If the peak areas associated with the three standard quantitation peaks (C_{10}, C_{12}, C_{14}) were within ±15% of the initial calibration values, the daily quality control standard was considered to have passed. If the area of any of the three peaks was not within ±15% of the standard peak, the check standard was reanalyzed until there was ±15% between the check standard and standard curve. After a day of sample analysis, a final check standard was run. Peak areas were compared with the initial check standard as well as with the standard curve and generally were in the quality criteria range.

2.2.2 Samples

Duplicate sample injections were acceptable if the areas of a majority of the major peaks were within the ±15% range from one injection to another.

Complete quantitation of the C_7 through C_{17} window in the samples was not possible because of solvent peak interference. All sample extracts had traces of the three extraction solvents (methylene chloride, *t*-butyl methyl ether, and toluene) as a result of the extraction procedures used for the condensates and the back-half rinses. Preliminary work with the train proof rinses showed that peaks associated with toluene (the solvent with the highest boiling point) eluted into the C_7-C_{17} window. Quantitation was possible about 348 s into the GC run. Since toluene was present in all samples, the summation of peak areas for TCO (total chromatographable organics) was started at 348 s and continued up to and included the retention time for C_{17}. The C_7 peak eluted at approximately 145 s while C_{10} eluted at approximately 453 s. It was estimated that C_9 would elute at approximately 365 s; hence, the summation for TCO includes peak areas falling in the C_9-C_{17} window.

TCO in the semivolatile samples was normalized to dodecane (C_{12}). The average response factors for C_{12} from the daily initial and final check standards for each day were used to calculate the TCO found in the samples analyzed that particular day. Results, reported in ppm dodecane, were divided into four window fractions--C_7-C_{10}, C_{10}-C_{12}, C_{12}-C_{14}, and C_{14}-C_{17}--as well as a total sum for the entire C_7-C_{17} window. Additionally, a factor of 4 (ratio of C_{12} to C_3) was used to convert the TCO in ppm dodecane to ppm propane.

2.3 NONVOLATILE ORGANICS ANALYSIS

Semivolatile and nonvolatile sample extraction was performed according to the procedure given in "POHCs and PICs Screening Protocol" (Southern Research Institute), Section III.C., with the following changes. All solvent rinses, filter, and XAD were combined and extracted with methylene chloride, again with methyl *t*-butyl ether, and a third time with toluene. Extraction blanks were analyzed for all three solvents. No surrogate spike was used. Further details of the extractions are given in Section 2.2.

The methylene chloride, *t*-butyl methyl ether, and toluene extracts from the MM5 train components were gravimetrically analyzed without deviation in accordance with the procedure in Section III.F. of "POHCs and PICs Screening Protocol." The precision and accuracy of duplicate analyses were based on two criteria:

- Duplicate sample weights had to be within ±20% of the average sample weight

- The difference between replicate weights had to be ≤ 0.1 mg (the required extent of accuracy)

A sample could fail the first test but still be within the limits of required accuracy; hence a sample was reanalyzed only if it did not pass the second test. Only one sample, the methylene chloride extract of the Run 7 condensate sample, did not pass the above criteria. The sample was reanalyzed in duplicate. The results of the second analysis easily passed the precision and accuracy criteria.

The respective method blank was subtracted from each sample. The remainder was multiplied by 10 to obtain the total μg per sample. Dividing by the dry standard sample volume gave μg of sample per L of air sampled. To obtain the ppm propane equivalent, it was assumed that half of the sample molecular weight had no FID response; thus ppm propane was calculated:

(μg of sample/L of air sampled)•(0.5)•(24.1 μL per μmol of gas/44 μg propane per μmol propane)

2.4 FORMALDEHYDE ANALYSIS

Formaldehyde analysis was performed according to "Determination of Aliphatic and Aromatic Aldehydes in Polluted Airs as Their 2,4-Dinitrophenylhydrazones by High Performance Liquid Chromatography," *J. Chromatogr. Sci.*, 17, 264-268 (1979). Exceptions to this procedure are as follows.

The entire impinger contents (~ 200 mL) were extracted with three 5-mL aliquots of dichloromethane. Dichloromethane was used to reduce the potential for significant blank levels. The entire sample was extracted to improve the method quantitation limit.

The following HPLC system and operational parameters were used for quantitation of the formaldehyde dinitrophenylhydrazone:

Guard column: 10 cm x 4.6 mm, Whatman C-18 pellicular packing

Analytical column: Partisil 5 ODS 3, particle size 5 µm, 25 cm x 4.6 mm ID, C-18

Detector: Spectrophotometric, 254 nm

Mobile phase: Acetonitrile/water (60/40)

Flow rate: Isocratic, 1.0 mL/min

The method accuracy was not measured from spiked air samples. The analysis method accuracy was determined by analyzing spiked blank samples, i.e., 200-mL water aliquots spiked with formaldehyde dinitrophenylhydrazone. The average recovery was 80% with an RSD of 8%.

APPENDIX A-3

QUALITY ASSURANCE AUDITS

Audits of sampling and laboratory activities were conducted to verify compliance, to verify systematic accuracy and traceability, and to verify accuracy and precision. The audits, along with corrective action requests for any perceived problems, were presented to project management. Copies of the audits were presented to department management and the QA Unit. The perceived problems were investigated by project management and project staff. If warranted, corrective actions were taken. The audit categories and the types of correction action taken for each category are described below.

Compliance: Compliance to the plan was evaluated during on-site systems audits and during records audits. Any compliance problems are discussed in the appropriate technical section of the report.

Systematic accuracy/traceability: Selected data were traced through the process. Where possible, the data were reconstructed mathematically. Any accuracy or traceability problems noted during the audit have been corrected.

Accuracy/precision: The accuracy and precision of standards, calibration, and samples were evaluated relative to the established criteria and to good laboratory practices. Any problems are discussed in the appropriate technical section of the report.

SECTION 1.0

SAMPLING ACTIVITIES

The project QA coordinator, Mr. Tom Dux, and a department QA coordinator, Mr. Dennis Hooton, conducted field systems audits on 7/22/88 for the metals and particulate tests. The department QA coordinator conducted a field systems audit on 8/2/88 for organics tests. The results of the audits, along with the corrective action responses, were distributed on 9/19/88. The results are summarized in this appendix.

Many of the methods used for this project were developmental and were undergoing change based on EPA comment, up to the start of the field test. The field audits were based on the draft plan, thus a number of deviations were noted that were not relevant to the final plan. The deviations noted below are only those relevant to the final plan issued on 8/16/88.

1.1 METALS AND PARTICULATE TESTS

Compliance: The sampling and sample preservation were not performed in compliance to the draft plan. The MM5 probe nozzle was changed due to the sample port configuration, with EPA's concurrence. The deviations were documented in the final plan. The procedures were conducted as described in the final plan.

Documentation: Flow rates to the Orsat sampling equipment were routinely adjusted, but the actual readings before adjustment were not documented. Only Runs 1 and 2 documented the fact that adjustments were made.

1.2 ORGANICS TEST

Compliance: The procedures were conducted as described in the final plan.

Documentation: Traceability forms were not used for the gas bags as required by the plan. However, the samples were adequately labeled and were traceable to their records.

SECTION 2.0

LABORATORY ACTIVITIES

A department QA coordinator, Mr. Dennis Hooton, reviewed the GC/FID calibration procedures during analyses on 8/2/88. After analysis, the project's QA coordinator, Mr. Tom Dux, reviewed the records and data for each type of analysis, except particulates, to evaluate systematic accuracy and traceability of reported sample results and to verify compliance to project procedures. The results of each audit, along with corrective action requests, were submitted to project management as follows: metals on 11/9/88, gases by Orsat on 10/27/88, volatiles on 11/10/88, semivolatiles/nonvolatiles by gravimetric on 10/27/88, semivolatiles by GC on 9/19/88 (calibration only) and 10/31/88, and formaldehyde on 10/3/88. The results of each audit are summarized below.

2.1 METALS BY ATOMIC EMISSION AND ATOMIC ABSORPTION

Note: Cr^{+6} data are not included in the discussion below.

2.1.1 Data Acquisition/Processing

Compliance: Original and final data for all metals were generated in accordance with the procedures.

Systematic accuracy/traceability: Arsenic calibration and standard preparation for 9/11 were verified. Particulate impactor stage 1 data for arsenic were verified and were traceable.

2.1.2 Accuracy/Precision

Standards: All of the check standard criteria were met. All of the reference standard criteria for NBS filters were met. Most of the criteria for NBS 1643b (trace elements in water) were met; this standard is used as a low level accuracy check. The results for NBS filters are as follows:

NBS standard	Recovery (%) As	Cd	Pb
2676 Ic or 2677 I*	93	96	97
2676 IIc or 2677 II*	110	102	112
2676 IIIc or 2677 III*	102	101	104

* As only.

Samples: Most of the accuracy (80-120% as recovery of a spike) and precision (±20% relative to the mean) objectives were met as shown below. According to the analyst, precision and/or accuracy may have been affected by one or more of the following reasons: the scrubber alkali was extremely viscous and the aqueous waste contained particulate matter.

Sample type	Recovery (%) As	Cd	Cr	Pb
Scrubber effluent	74*	101	69*	81
Scrubber alkali	119	110	93	245*
Aqueous waste	a	115	219*	313*
Organic waste	118	99	102	105

[a] Spiked too low.
* Did not meet objective.

Sample type	Precision (%) As	Cd	Cr	Pb
Run 2, front half	0.55	0.56	1.6	2.0
Run 2, back half	1.3	0.88	2.5	4.9
Scrubber effluent	5.9	4.3	3.1	80*
Scrubber alkali	44*	a	9.4	a
Aqueous waste	1.1	a	28*	128*
Particulate impactor				
Stage 1	a	0.55	0.3	1.9
Stage 2	a	2.6	2.7	1.4
Cyclone	a	0.0	4.2	2.8
Final stage and thimble	4.9	3.0	0.97	1.6
Organic waste	a	a	5.2	a

[a] Near the detection limit.
* Did not meet objective.

2.2 GASES BY ORSAT ANALYSIS

2.2.1 Data Acquisition/Processing

Compliance: Original data were generated and processed in accordance with the procedure.

Systematic accuracy/traceability: Data for Run 9 were verified. No systematic problems were detected.

2.2.2 Accuracy/Precision

Standards: No objectives were established.

Samples: No objectives were established.

2.3 VOLATILES BY GAS CHROMATOGRAPHY ANALYSIS

2.3.1 Data Acquisition/Processing

Compliance: Data were generated in accordance with the plan.

Systematic accuracy/traceability: The calibration curve for C_1-C_4 was verified. The response factors used for C_3-C_7 Tedlar bag (DB-1) analysis were not correct. The data were recalculated. The results for Run 9 samples were traceable.

2.3.2 Accuracy/Precision

Standards: Certified standards were used for the initial calibration. Calibration criteria for a daily standard was established as ±15% from the initial calibration. Run 9 daily calibration was examined. The criteria was met.

Samples: Precision objectives for samples were established as ±15% for duplicate injections. Precision was continuously monitored. Run 9 results were examined during the audit. The results met the criteria.

2.4 NONVOLATILES BY GRAVIMETRIC ANALYSIS

2.4.1 Data Acquisition/Processing

Compliance: Original data were generated in accordance with the procedure.

Systematic accuracy/traceability: The calibration check of the balance was examined for all days. All samples from Run 9 were completely traced through the documentation and verified. No systematic accuracy problems were noted with the following exceptions: the individual results for triplicate extractions of the train and condensates were first blank-corrected then summed for a total concentration. However, some of the samples and/or blanks had negative values. It was requested that the use of negative numbers and values less than the detection limit be discussed in the report. The method of calculation has been provided in the report.

Sample results were traceable with the following exceptions: the calculations in terms of µg/L and results for the total sample volume were not in the original records audited. The formula and assumption for converting µg/L to ppm and the sample volumes are provided in the report.

2.4.2 Accuracy/Precision

Standards: The accuracy objective for duplicate weighings was 0.1 mg. This criteria was met.

Samples: The precision objective was ±20% for duplicate analyses. Fifty-five percent of the determinations met the criteria. The remainder of the determinations were near the detection limit of 66 μg* and should not be considered as part of a completeness objective for precision.

2.5 SEMIVOLATILES (C_7-C_{17}) BY GAS CHROMATOGRAPHY

2.5.1 Data Acquisition/Processing

Compliance: Original data were generated in accordance with the procedure and within the holding times. Calibration deviations from the draft plan were included in the final plan. However, final data were not calculated in accordance with the procedure. The calibration curve was planned to be a linear regression curve derived from calibration standard total responses vs. total concentration. Instead, the calibration used was a response factor (RF) derived from the daily calibration. Blank-corrected sample total responses were planned to be used to obtain total concentration. Instead, nonblank-corrected sample total responses were used. The deviations and justifications are provided in the report. The results are to be blank-corrected for the report.

Systematic accuracy/traceability: The calibration data for 9/20 were verified. Methylene chloride condensate data for Run 9 were reconstructed and thus verified. No systematic accuracy problems were noted. Data were traceable, with the exceptions of propane calculations for μg/L and the conversion to ppm. The calculations for μg/L and the total sample volume were not in the original records audited. The formula and assumption for converting μg/L to ppm and the sample volumes are provided in the report.

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* Calibration by a 1-g standard was performed before and after each set of weighings, resulting in a mean of 1.000002 g and a standard deviation of 0.000022 g (or 22 μg) from 64 readings. If the method detection limit is defined as 3 times the standard deviation, then the actual detection limit is (3 x 22 μg) or 66 μg.

2.5.2 Accuracy/Precision

Standards: Calibration criteria for a daily standard was established as ±15% from the initial calibration. Two injections for 9/20 were examined during the audit. The injections met the criteria.

Samples: Precision objectives for samples were established as ±15% for duplicate injections. Precision was continuously monitored. Some of the results were calculated and it was noted that some of the samples did not meet criteria. The data were rechecked as appropriate.

2.6 FORMALDEHYDE BY HIGH PERFORMANCE LIQUID CHROMATOGRAPHY

2.6.1 Data Acquisition/Processing

Compliance: Compliance could not be determined because the procedure referenced in the plan was too general. The necessary additional detail has been provided in the report.

Systematic accuracy/traceability: Standard concentrations, the first analysis curve, and Sample 9016 results were verified. Sample 9016 results were traceable up to the formaldehyde-DPNH (FDPNH) derivation concentration. The conversion to free formaldehyde was not done, yet the results were presented as formaldehyde. This was discussed with project staff and the free formaldehyde was then calculated.

2.6.2 Accuracy/Precision

Standards: The analytical standard FDPNH was synthesized and purified. The purity had not been documented. The standard was later characterized by high resolution nuclear magnetic resonance. The spectrum was consistent with the proposed chemical structure and no impurities were found.

An FDPNH performance standard in acetonitrile was independently prepared from the synthesized standard. The result of 80% accuracy was well within the 60-140% accuracy objective.

Samples: Precision objectives (±15% relative to the mean) were met.

APPENDIX B

DATA TABLES

B-1. CEM Data
B-2. Particulate/Particle Size Data
B-3. Metals Data
B-4. Organic Analysis Data
B-5. Formaldehyde Data
B-6. Mobay Process Data

APPENDIX B-1

CEM DATA

Table B-1-1. CEM Data Summary
Table B-1-2. CEM Calibration Summary
Table B-1-3. CEM Response Delay Times (Minutes)
Table B-1-4. CEM Data

TABLE B-1-1. CEN DATA SUMMARY

	O_2 (%)	O_2 (%) 1 min avg.	CO_2 (%)	CO (ppm)	CO (ppm) 1 min avg.	CO (ppm) corrected to 7% O_2	CO (ppm) 1 min avg. corrected to 7% O_2	CO (ppm) 1 hr avg. corrected to 7% O_2	THC (ppm) heated, wet	THC (ppm) heated, dry	THC (ppm) unheated
Run 5											
Average	5.3	5.3	10.4	124.6	124.6	110.9	110.9	102.4	15.6	36.4	3.6
Low	4.5	4.5	10.1	48.2	49.4	43.7	44.8	73.2	3.7	8.6	2.2
High	5.8	5.8	11.0	221.1	218.2	198.2	195.6	148.0	24.9	58.2	6.4
Std. deviation	0.3	0.3	0.1	40.9	40.7	38.1	35.9	21.1	3.3	7.6	0.8
Variance	0.1	0.1	0.0	1,674.0	1,655.6	1,300.7	1,289.3	445.9	10.6	57.7	0.7
Run 6											
Average	5.4	5.4	10.2	510.6	510.7	460.2	460.3	452.7	34.5	88.0	12.0
Low	4.1	4.3	9.6	329.4	332.6	291.3	293.6	380.6	16.0	40.8	9.7
High	6.3	6.0	10.6	1,003.7	799.8	844.0	694.0	546.6	40.6	103.6	18.6
Std. deviation	0.2	0.2	0.2	82.8	79.5	78.3	75.3	50.7	2.3	6.0	1.4
Variance	0.1	0.0	0.0	6,850.1	6,319.6	6,133.7	5,672.8	2,573.7	5.5	35.8	2.0
Run 7											
Average	6.6	6.6	9.6	1,098.9	1099.2	1068.1	1,068.3	1,057.6	88.6	207.0	7.6
Low	6.0	6.2	9.4	781.1	849.4	748.5	810.7	960.8	11.8	27.6	5.5
High	7.0	6.9	10.0	1,385.8	1,350.5	1,349.6	1,313.3	1,132.0	121.5	283.9	10.3
Std. deviation	0.1	0.1	0.1	100.3	92.3	100.0	92.3	46.9	16.6	38.9	1.5
Variance	0.0	0.0	0.0	10,052.2	8,526.7	10,003.4	8,520.2	2,195.9	277.1	1,512.7	2.2
Run 8											
Average	7.1	7.1	10.2	2,460.2	2,462.5	2,464.4	2,465.7	2,466.5	95.5	226.8	60.5
Low	5.8	5.8	9.6	1,099.9	1,107.3	1,113.2	1,129.1	2,267.2	35.5	84.3	7.5
High	8.5	8.3	10.9	3,157.0	3,144.9	3,080.9	2,993.9	2,607.2	158.9	377.4	118.2
Std. deviation	0.5	0.5	0.2	446.7	437.8	409.4	397.2	87.8	30.9	73.5	27.0
Variance	0.3	0.3	0.0	199,497.0	191,692.8	167,582.5	157,786.8	7,707.1	957.9	5,404.2	726.7
Run 8S											
Average	4.7	4.7	10.6	195.5	196.0	167.9	168.3	161.6	21.6	51.2	6.7
Low	4.6	4.6	10.5	174.3	177.3	149.2	151.8	154.1	20.6	48.9	5.7
High	4.8	4.8	10.8	224.8	219.0	193.1	188.8	165.3	22.9	54.4	7.4
Std. deviation	0.1	0.1	0.1	11.4	11.3	10.1	10.0	2.0	0.4	1.0	0.4
Variance	0.0	0.0	0.0	131.1	128.6	101.4	100.2	4.1	0.2	1.0	0.2

(continued)

TABLE B-1-1 (continued)

	O_2 (%)	O_2 (%) 1 min avg.	CO_2 (%)	CO (ppm)	CO (ppm) 1 min avg.	CO (ppm) corrected to 7% O_2	CO (ppm) 1 min avg. corrected to 7% O_2	CO (ppm) 1 hr avg. corrected to 7% O_2	THC (ppm) heated, wet	THC (ppm) heated, dry	THC (ppm) unheated
Run 9											
Average	2.2	2.2	12.8	3,704.5	3,704.6	2,761.9	2,761.9	2,762.4	71.3	199.1	61.4
Low	2.1	2.1	12.5	2,870.0	2,920.3	2,149.8	2,189.8	2,656.2	44.1	123.2	41.5
High	2.4	2.4	13.0	4,900.7	4,116.3	3,643.6	3,069.2	2,904.2	104.3	291.3	101.2
Std. deviation	0.1	0.1	0.1	240.8	232.2	177.6	170.9	63.2	11.8	33.0	10.5
Variance	0.0	0.0	0.0	57,999.6	53,897.8	31,554.3	29,216.6	3,989.4	139.6	1,089.4	109.2
Run 10											
Average	4.8	4.8	10.8	2,457.5	2,456.5	2,128.4	2,127.4	2,153.0	33.7	85.6	18.0
Low	4.4	4.4	10.3	2,155.9	2,227.4	1,837.0	1,901.8	2,035.9	26.5	67.4	13.1
High	5.6	5.4	11.2	2,829.4	2,767.8	2,461.9	2,426.4	2,274.1	42.8	108.9	27.6
Std. deviation	0.2	0.2	0.2	113.9	108.4	113.6	108.9	62.3	2.9	7.3	2.8
Variance	0.0	0.0	0.0	13,018.0	11,740.1	12,948.5	11,863.0	3,887.0	8.3	53.7	7.9

TABLE B-1-2. CEM CALIBRATION SUMMARY

Parameter	Zero		Span		Drift[a] (%)	
	Initial	Final	Initial	Final	Zero	Span
Run 5 (1416-1735)						
O_2	3.67	4.07	54.57	54.38	0.79	1.17
CO_2	3.45	2.56	82.59	81.79	1.12	0.11
CO	5.75	5.98	50.39	49.07	0.52	3.53
THC	7.13	5.32	31.96	31.81	7.05	6.47
UTHC	14.84	21.34	56.93	67.5	14.73	9.22
Run 6 (1335-1339, 1347-1732)						
O_2	2.73	2.86	53.48	53.13	0.26	0.95
CO_2	2.87	3.21	81.55	80.88	0.43	1.29
CO	2.05	2.53	26.4	25.84	2.01	4.36
THC	2.57	2.45	6.89	7.86	2.47	22.40
UTHC	15.87	14.1	39.08	36.86	7.70	1.96
Run 7 (1100-1424)						
O_2	1.59	1.91	51.85	51.17	0.64	2.01
CO_2	2.53	3.36	80.73	80.56	1.07	1.29
CO	2.11	3.32	49.11	48.14	2.64	4.75
THC	4.36	2.31	67.44	74.11	3.04	12.93
UTHC	3.69	4.29	78.18	58.03	0.94	32.36
Run 8 (0945-1309)						
O_2	1.56	2.01	51.4	51.36	0.91	0.99
CO_2	2.82	4.11	80.25	80.84	1.67	0.91
CO	1.97	3.06	98.71	98.06	1.14	1.81
Run 8A (0943-0959)						
THC	3.75	3.28	82.56	94.21	0.55	14.28
UTHC	4.36	4.5	60.92	61.74	0.25	1.20
Run 8B (1006-1100)						
THC	3.28	3.17	94.21	76.76	0.13	21.08
UTHC	4.5	4.23	61.74	61.31	0.47	0.28

(continued)

TABLE B-1-2 (continued)

Parameter	Zero		Span		Drift[a] (%)	
	Initial	Final	Initial	Final	Zero	Span
Run 8C (1108-1200)						
THC	3.17	2.95	76.76	80.5	0.29	5.24
UTHC	4.23	4.2	61.31	61.1	0.05	0.32
Run 8D (1209-1307)						
THC	2.95	2.86	80.5	78.38	0.12	2.65
UTHC	4.2	4.47	61.1	59.79	0.48	2.82
Run 8S (1437-1508)						
O_2	2.01	2.18	51.36	51.25	0.35	0.57
CO_2	4.11	4.26	80.34	80.53	0.20	0.05
CO	7.26	6.44	50.99	49.58	1.89	1.36
THC	2.86	2.83	78.38	78.42	0.04	0.09
UTHC	4.47	5.06	59.79	59.49	1.08	1.62
Run 9 (1218-1514, 1540-1608)						
O_2	1.64	1.42	51.65	50.94	0.44	0.98
CO_2	2.71	2.85	80.78	80.41	0.18	0.66
CO	3.66	4.29	79.69	75.01	0.86	7.24
Run 9A (1215-1253)						
THC	2.2	2.15	69.32	61.03	0.08	13.08
UTHC	5.03	4.7	61.75	62.24	0.58	1.44
Run 9B (1302-1352)						
THC	2.15	2.2	61.03	124.06	0.06	69.69
UTHC	4.7	4.15	62.24	62.4	0.95	1.23
Run 9C (1404-1506)						
THC	2.2	2.2	124.06	120.24	0.00	3.18
UTHC	4.15	4.04	62.4	63.14	0.19	1.45

(continued)

TABLE B-1-2 (continued)

Parameter	Zero Initial	Zero Final	Span Initial	Span Final	Drift[a] (%) Zero	Drift[a] (%) Span
Run 9D (1540-1603)						
THC	1.75	1.76	120.24	89.29	0.01	30.06
UTHC	4.04	4.25	63.14	62.96	0.36	0.66
Run 10 (1127-1451)						
O_2	1.63	2.1	51.16	50.84	0.96	1.61
CO_2	2.15	2.8	80.29	79.92	0.84	1.31
CO	5.21	4.83	77.91	77.3	0.52	0.32
Run 10A (1127-1143)						
THC	3.33	3.06	58.1	57.55	0.49	0.51
UTHC	3.83	3.9	60.81	57.81	0.13	5.54
Run 10B (1151-1257)						
THC	3.06	3.06	57.55	57.14	0.00	0.76
UTHC	3.9	4.04	57.81	58.4	0.26	0.83
Run 10C (1312-1359)						
THC	3.06	2.8	57.14	58.02	0.48	2.09
UTHC	4.04	4	58.4	55.62	0.08	5.17
Run 10D (1408-1451)						
THC	2.8	2.71	58.02	57.76	0.16	0.31
UTHC	4	4.1	55.62	58.28	0.19	4.84

[a] Based on average span.

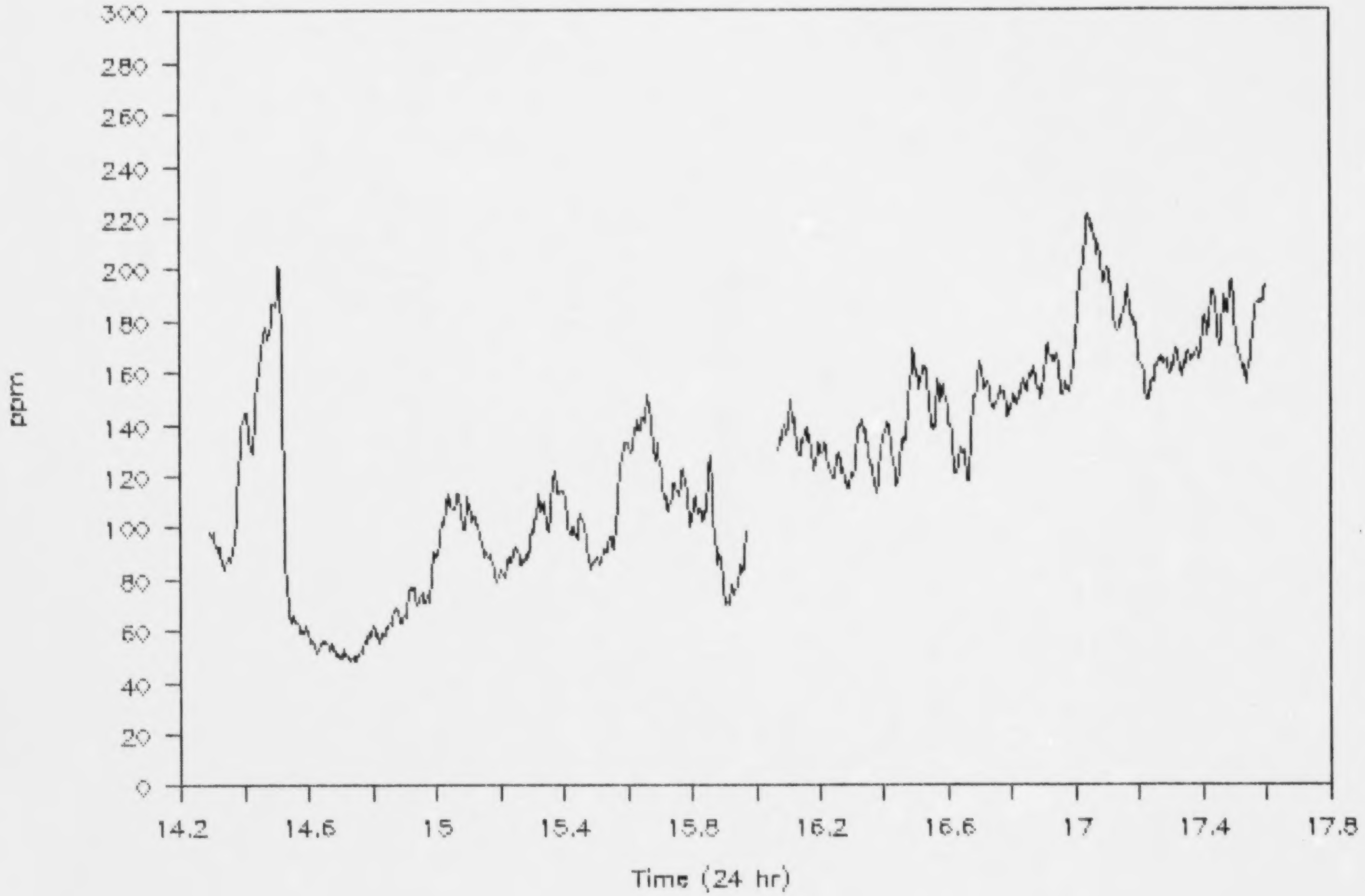
TABLE B-1-3. CEM RESPONSE DELAY TIMES[a] (MINUTES)

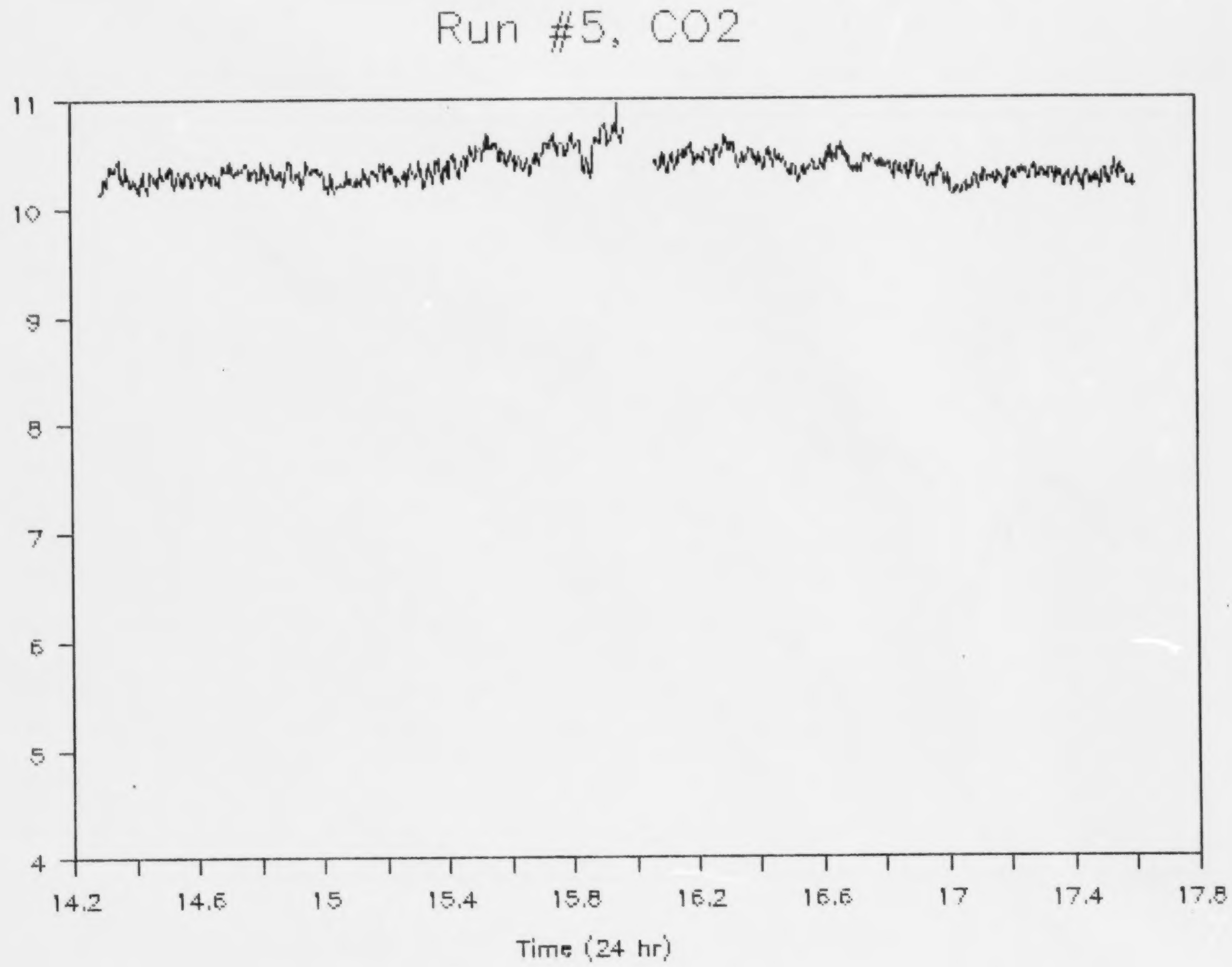
Run	O_2	CO_2	CO	THC	UTHC
5	3:50	3:20	3:40	2:00	1:30
6	2:40	3:00	2:50	2:00	2:20
7	3:00	3:20	3:10	3:10	2:00
8	3:00	3:20	4:00	2:10	2:10
8S	3:00	3:20	4:00	2:10	2:10
9	3:30	3:50	3:00	2:00	2:00
10	3:10	4:00	3:40	3:30	2:00

[a] Delay time measured to 95% of reading.

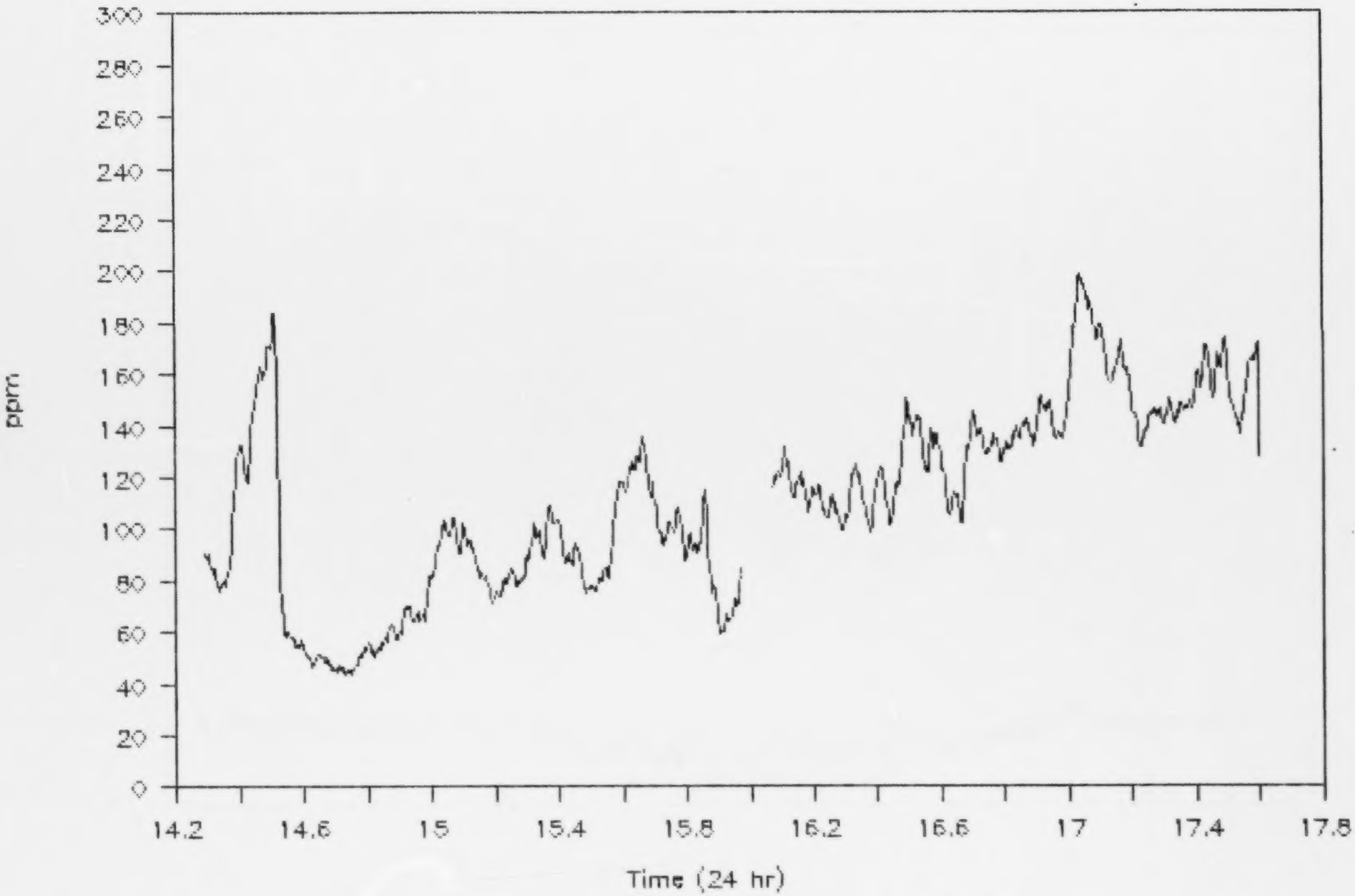
Table B-1-4. CEM Data

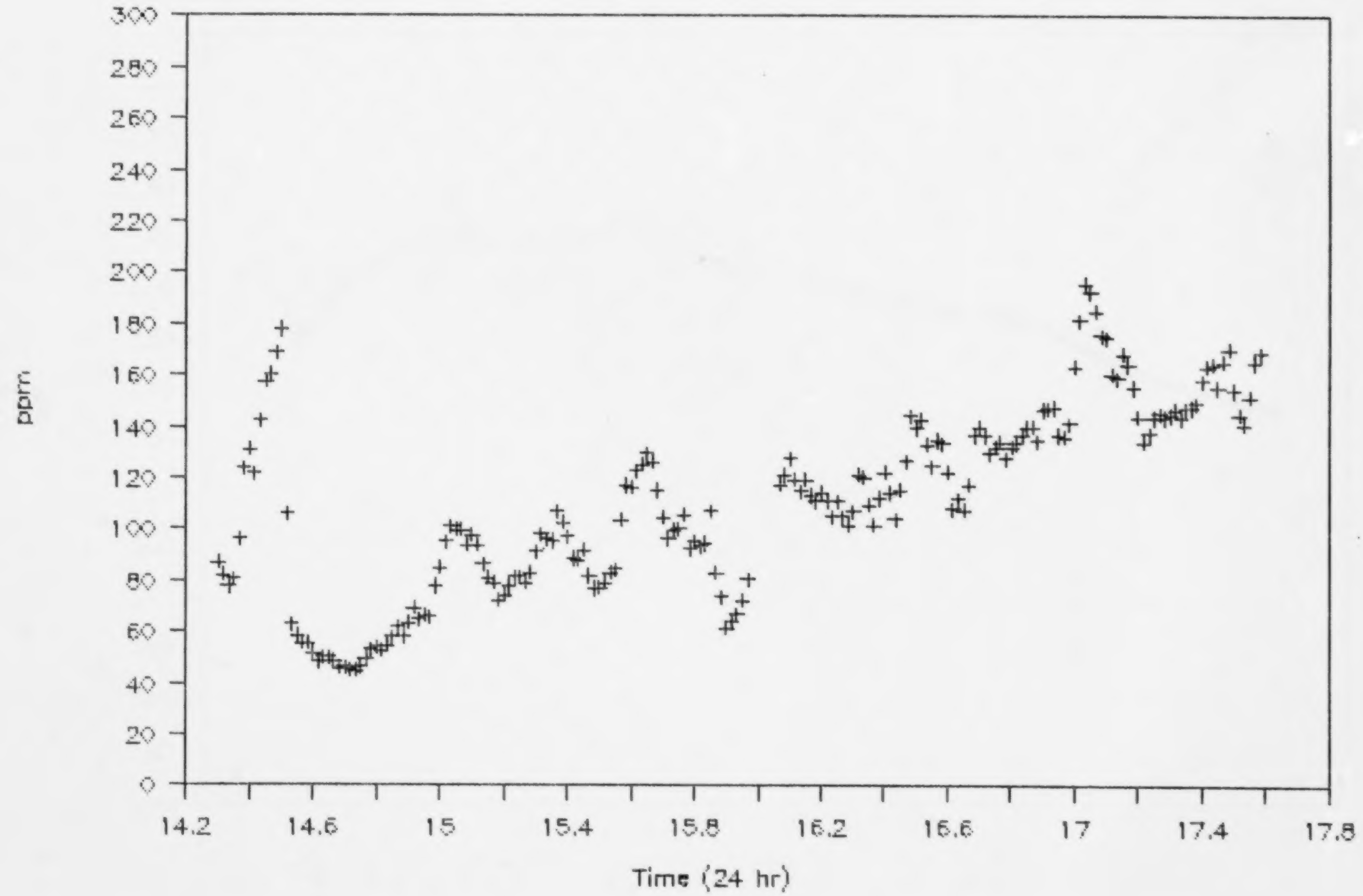
Run #5, CO


ppm
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
14.2
14.6
15
15.4
15.8
16.2
16.6
17
17.4
17.8
Time (24 hr)

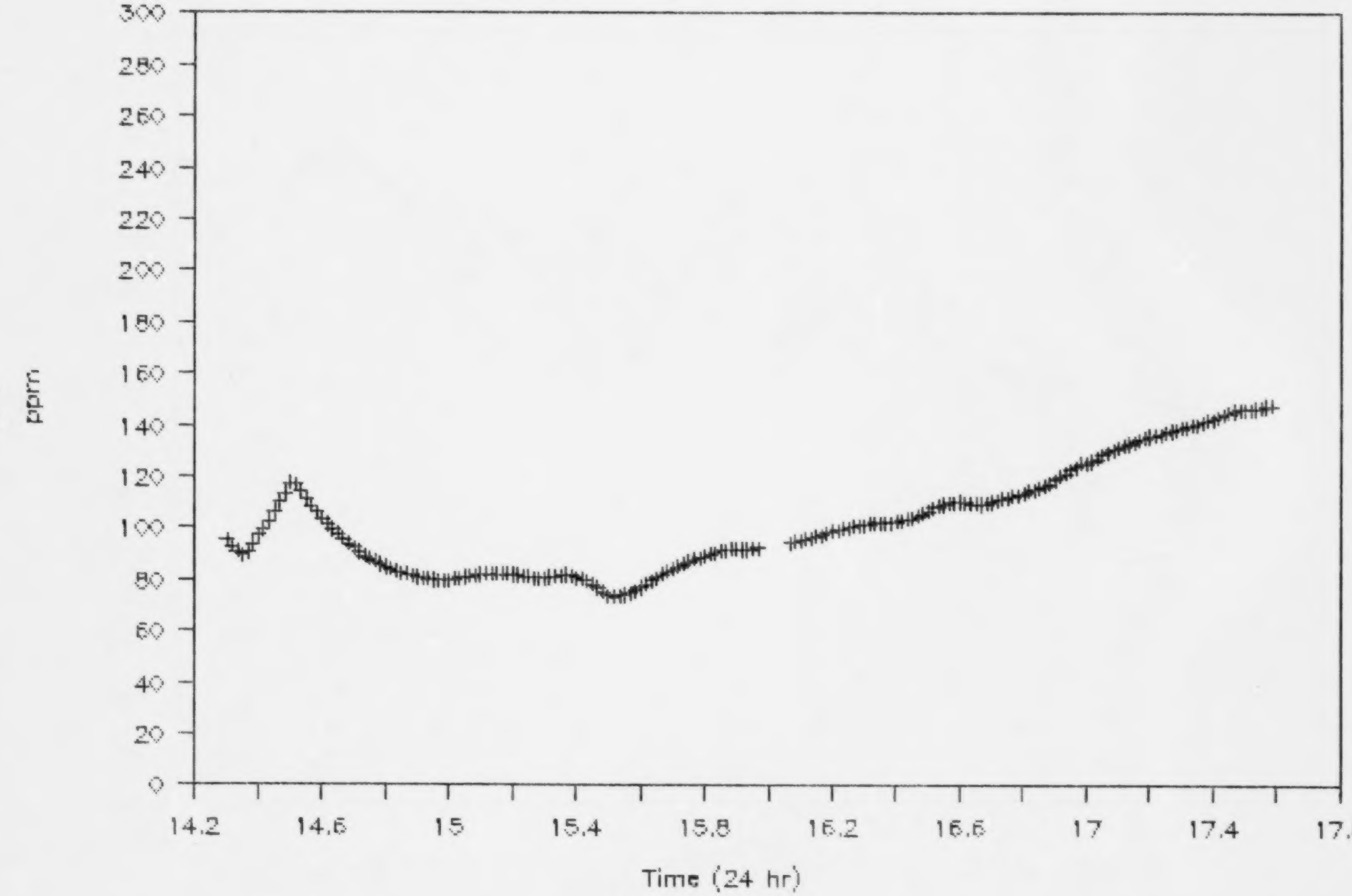

Run #5, CO2
Percent
11
10
9
8
7
6
5
4
14.2
14.6
15
15.4
15.8
16.2
16.6
17
17.4
17.8
Time (24 hr)

Run #5, CO (7% Oxygen)

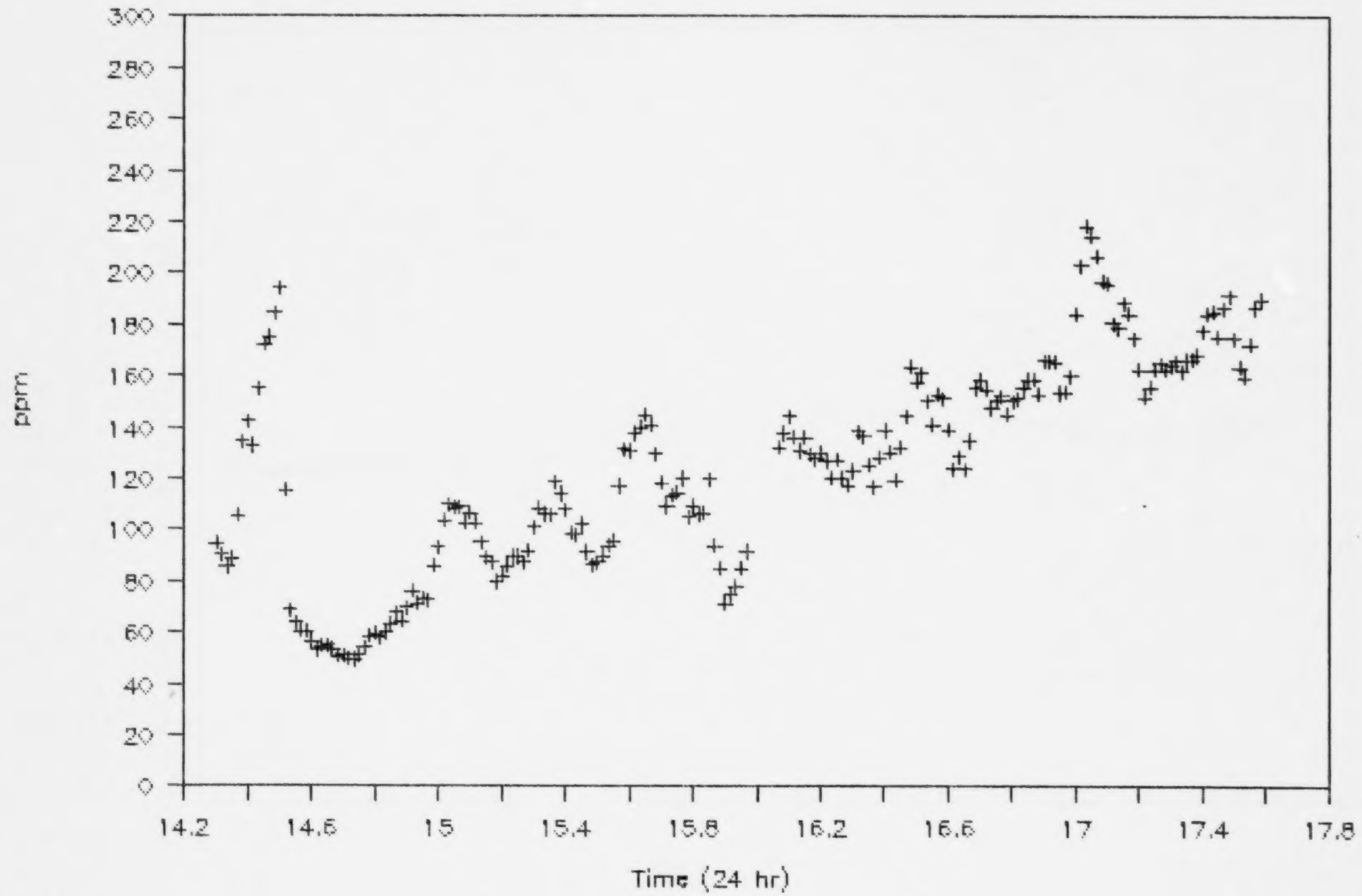



Run #5, CO (7% Oxygen), 1 min avg.

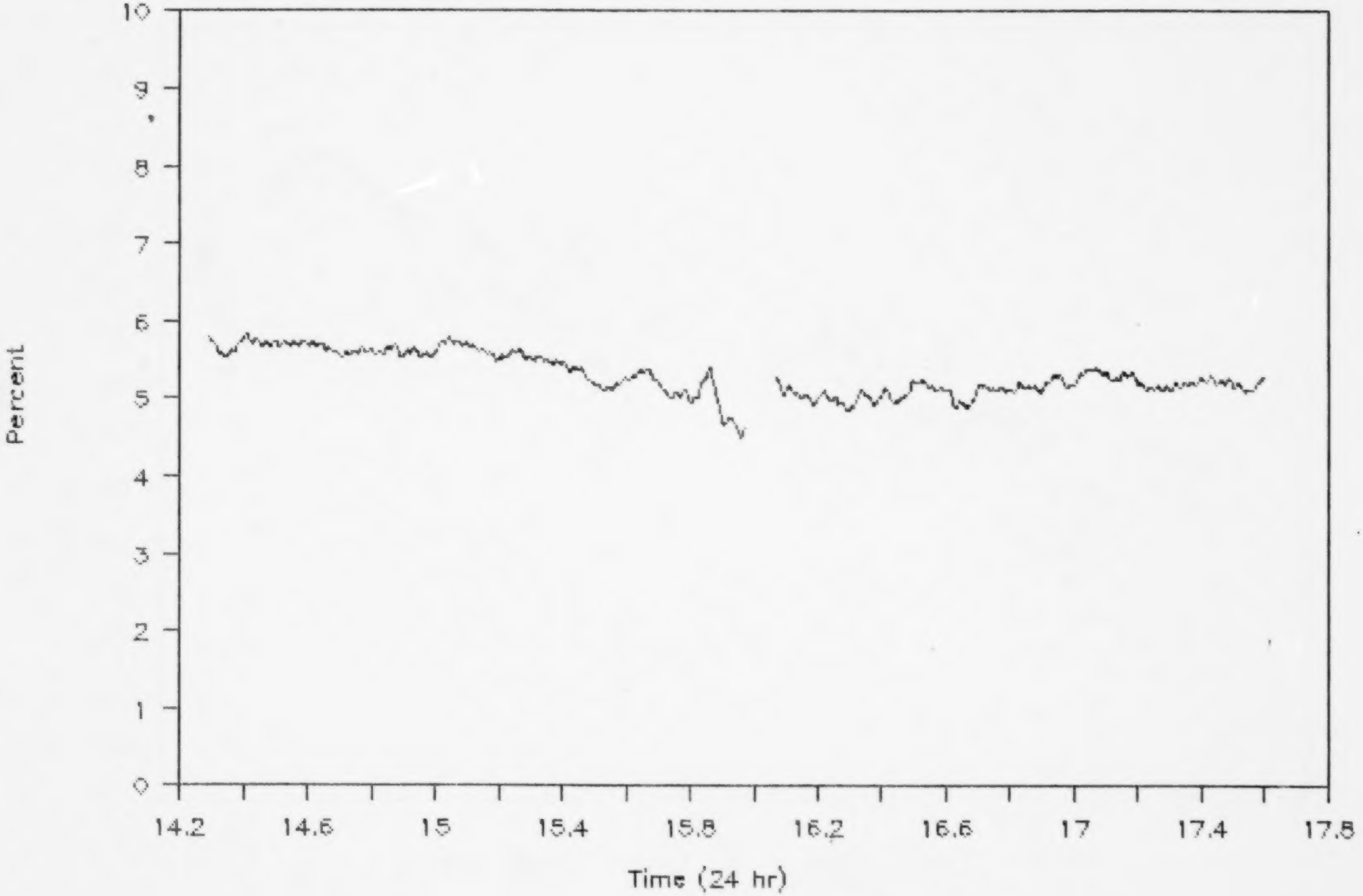
Run #5, CO (7% Oxygen), 1 hr roll avg.



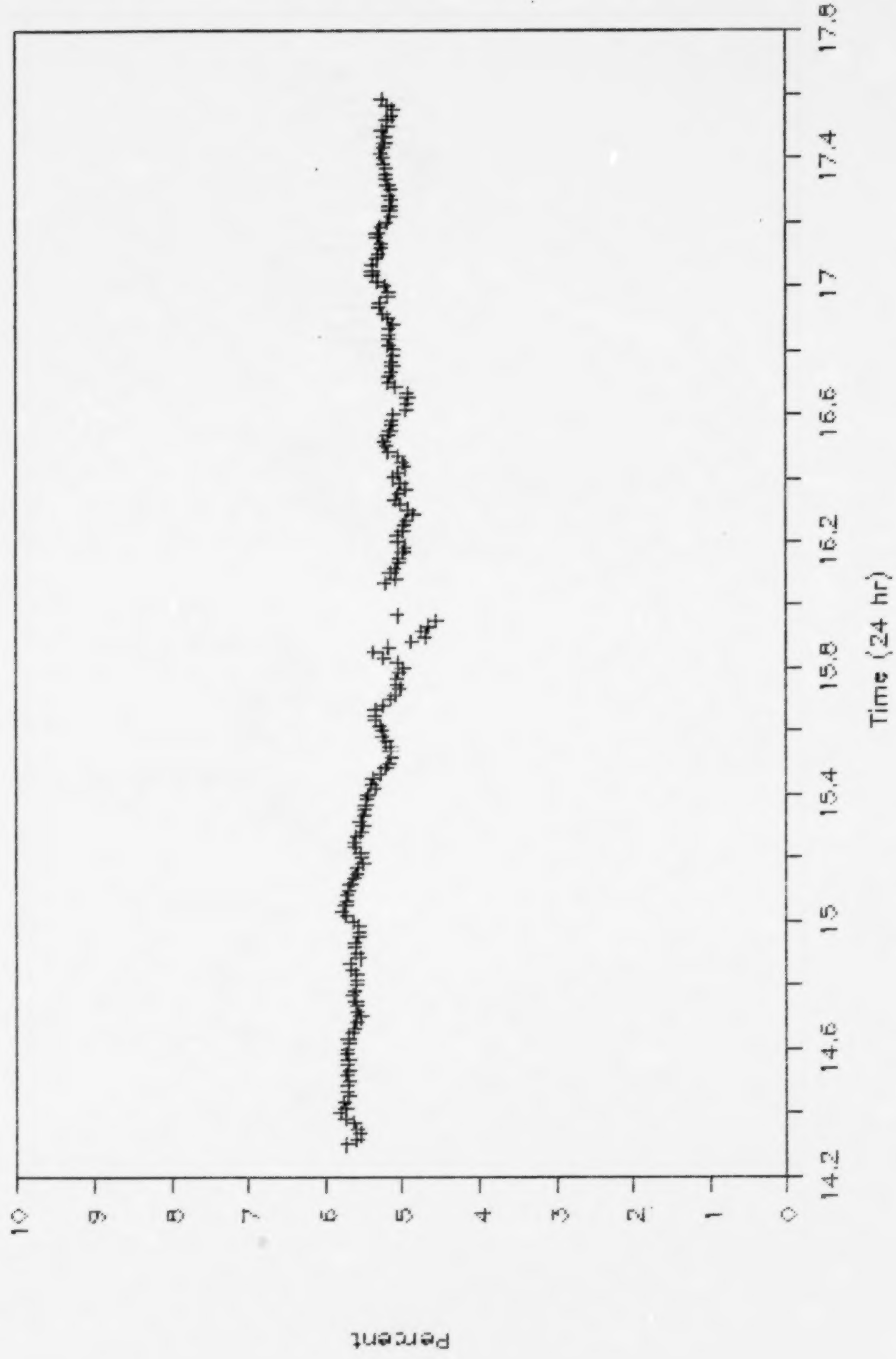
Run #5, CO, 1 min avg.

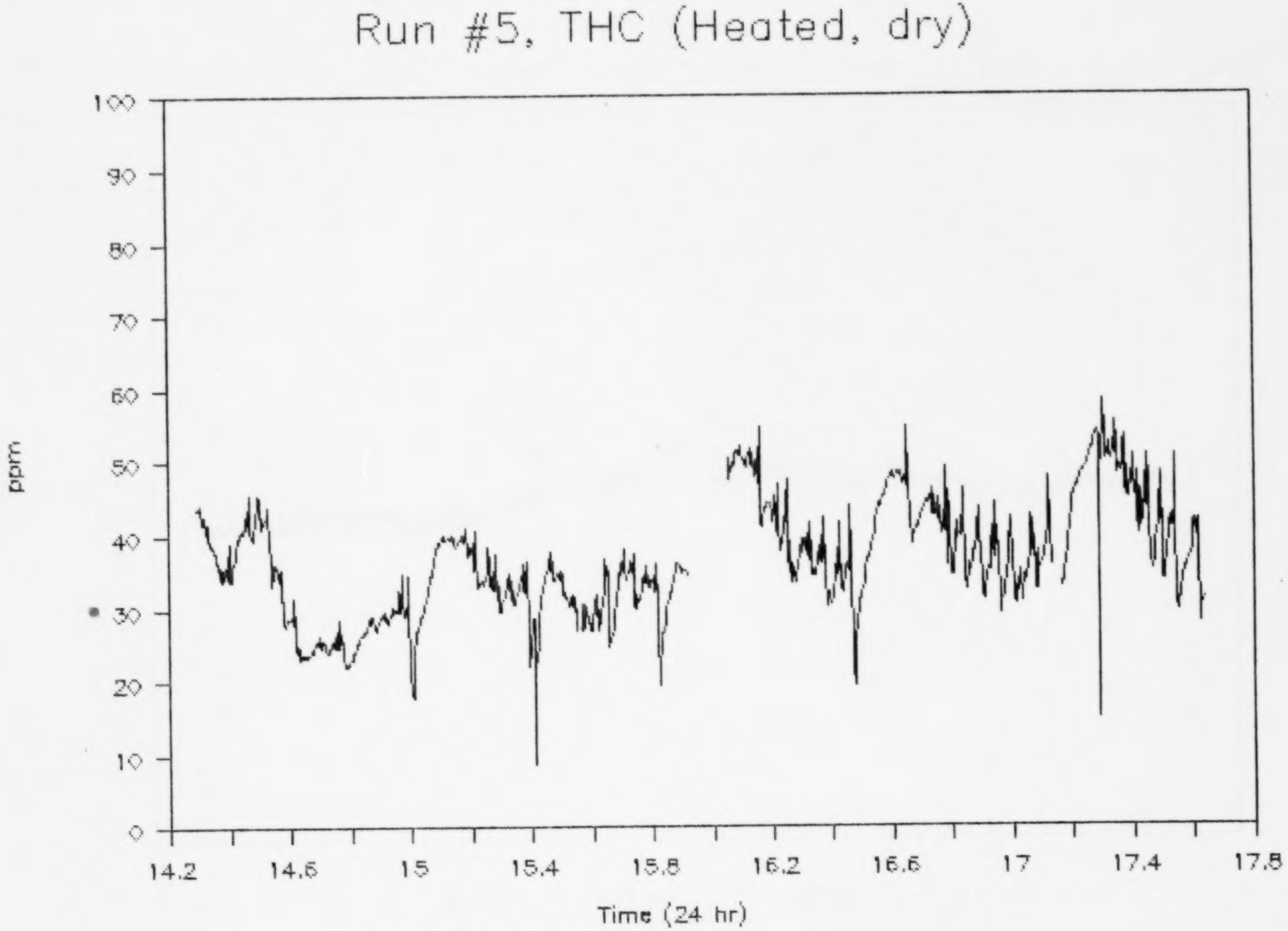


Run #5, Oxygen

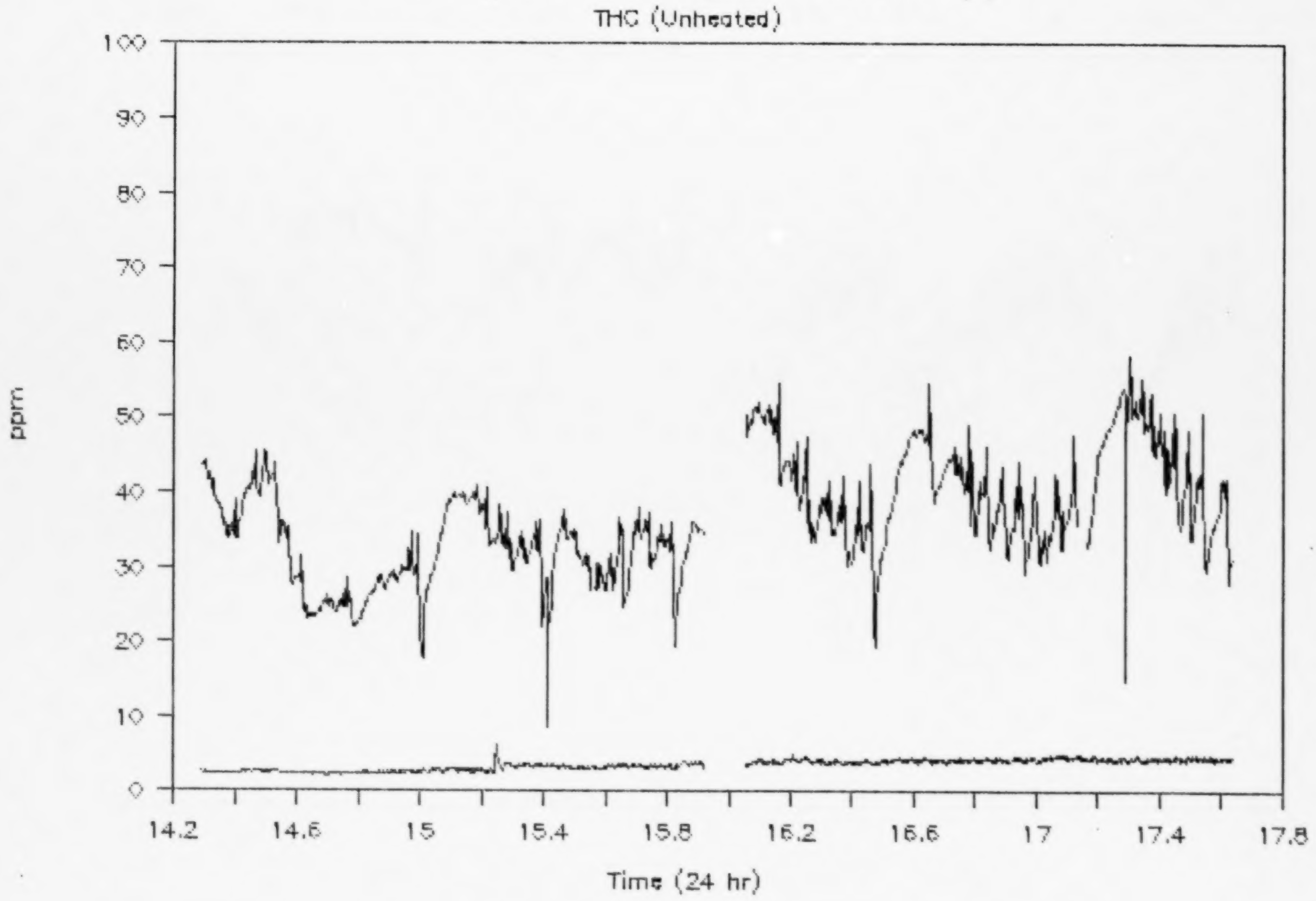

10
9
8
7
6
5
4
3
2
1
0
Percent
14.2
14.6
15
15.4
15.8
16.2
16.6
17
17.4
17.8
Time (24 hr)

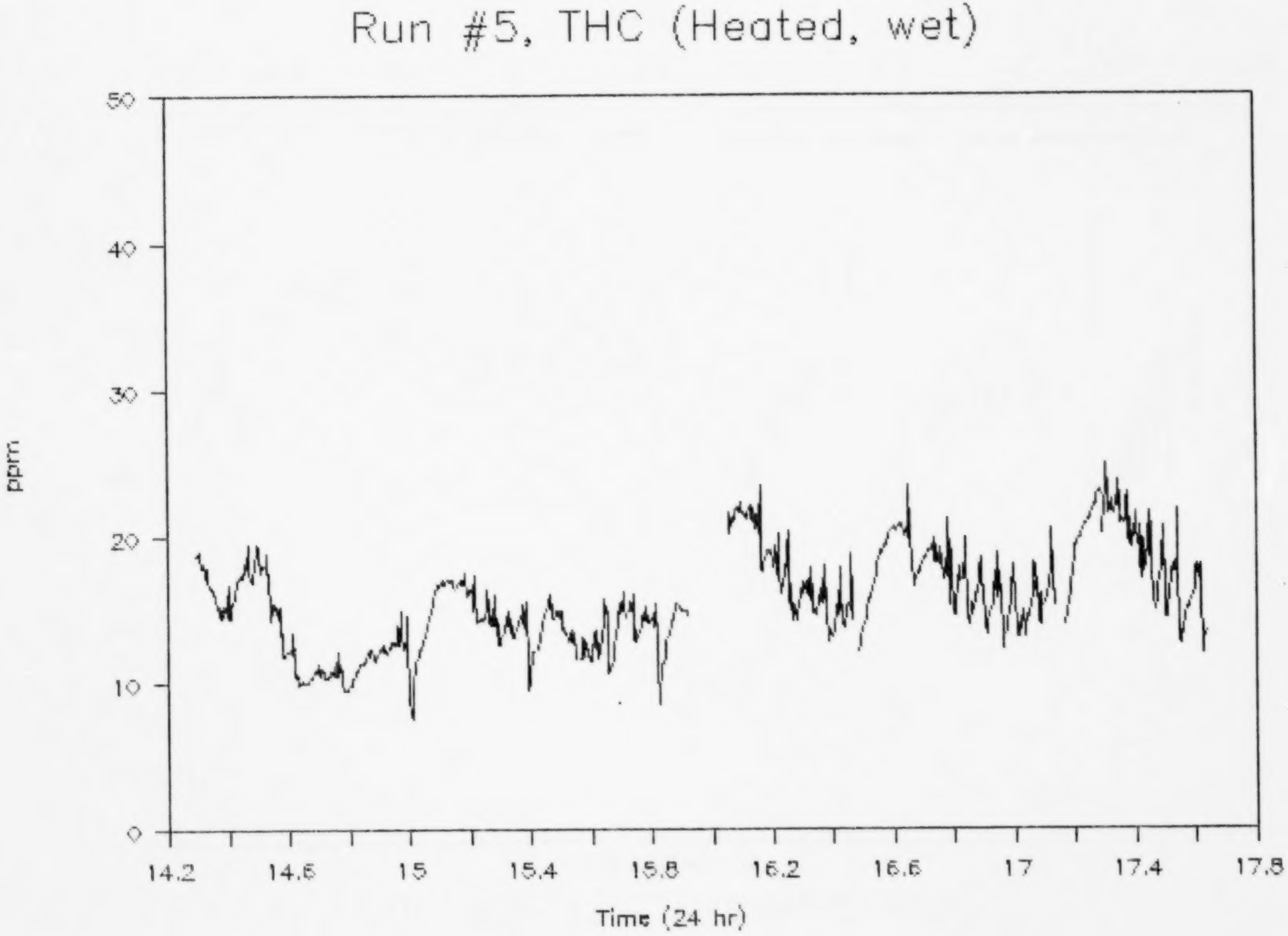
Run #5, Oxygen, 1 min avg.



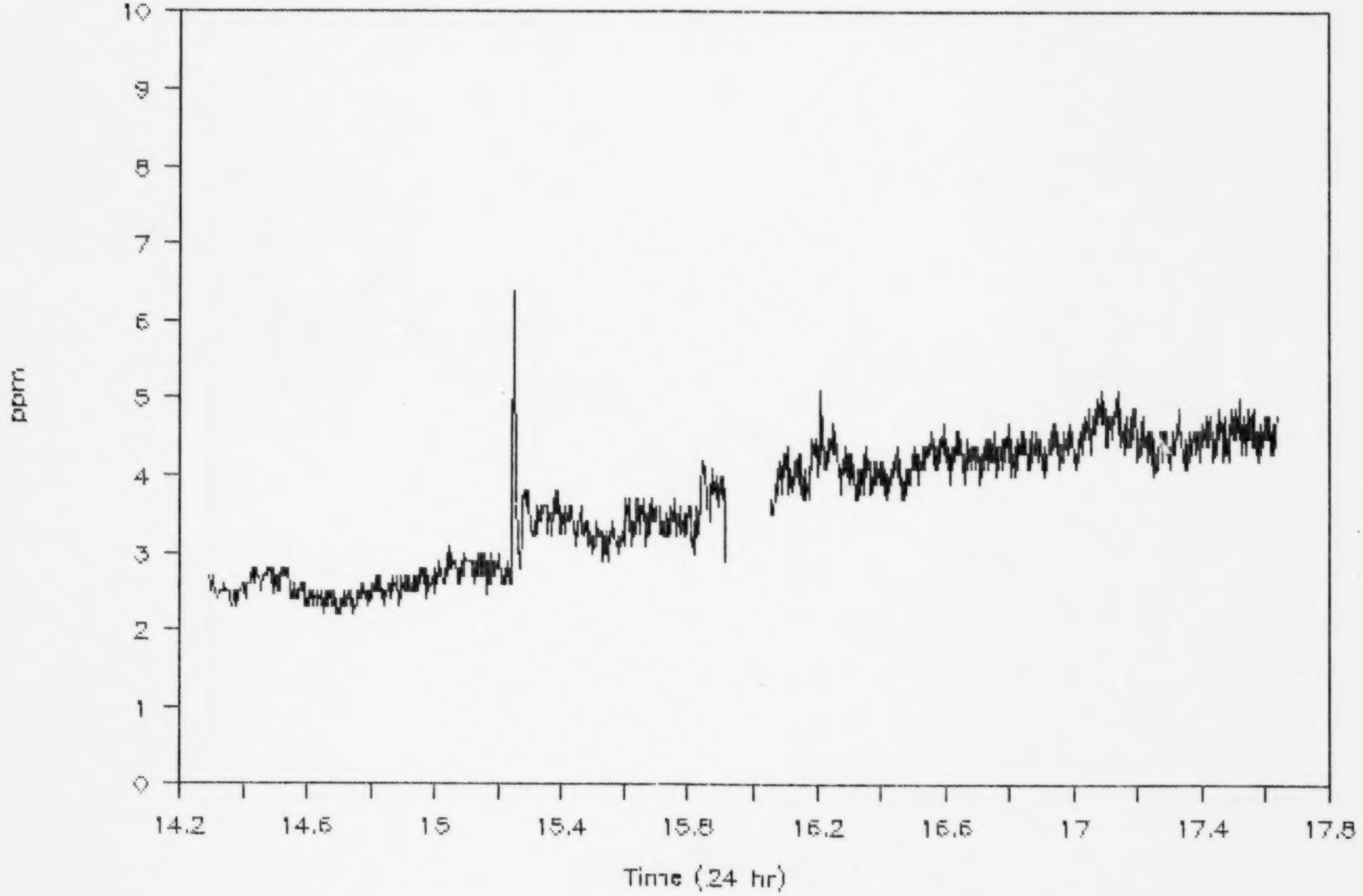

Run #5, THC (Heated, dry)
ppm
100
90
80
70
60
50
40
30
20
10
0
14.2
14.6
15
15.4
15.8
16.2
16.6
17
17.4
17.8
Time (24 hr)

Run #5, THC (Heated, dry)

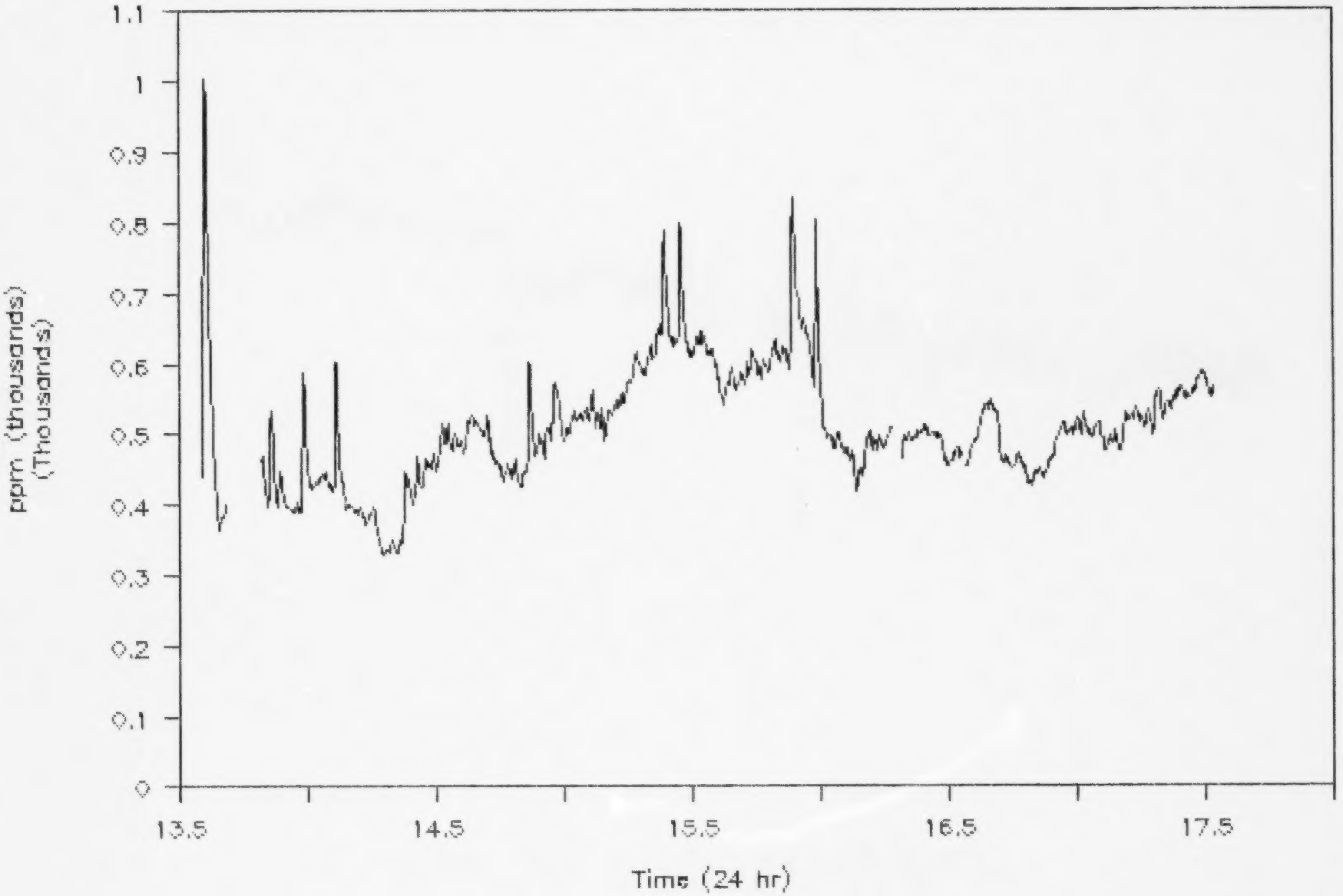



Run #5, THC (Heated, wet)
ppm
50
40
30
20
10
0
14.2
14.6
15
15.4
15.8
16.2
16.6
17
17.4
17.8
Time (24 hr)

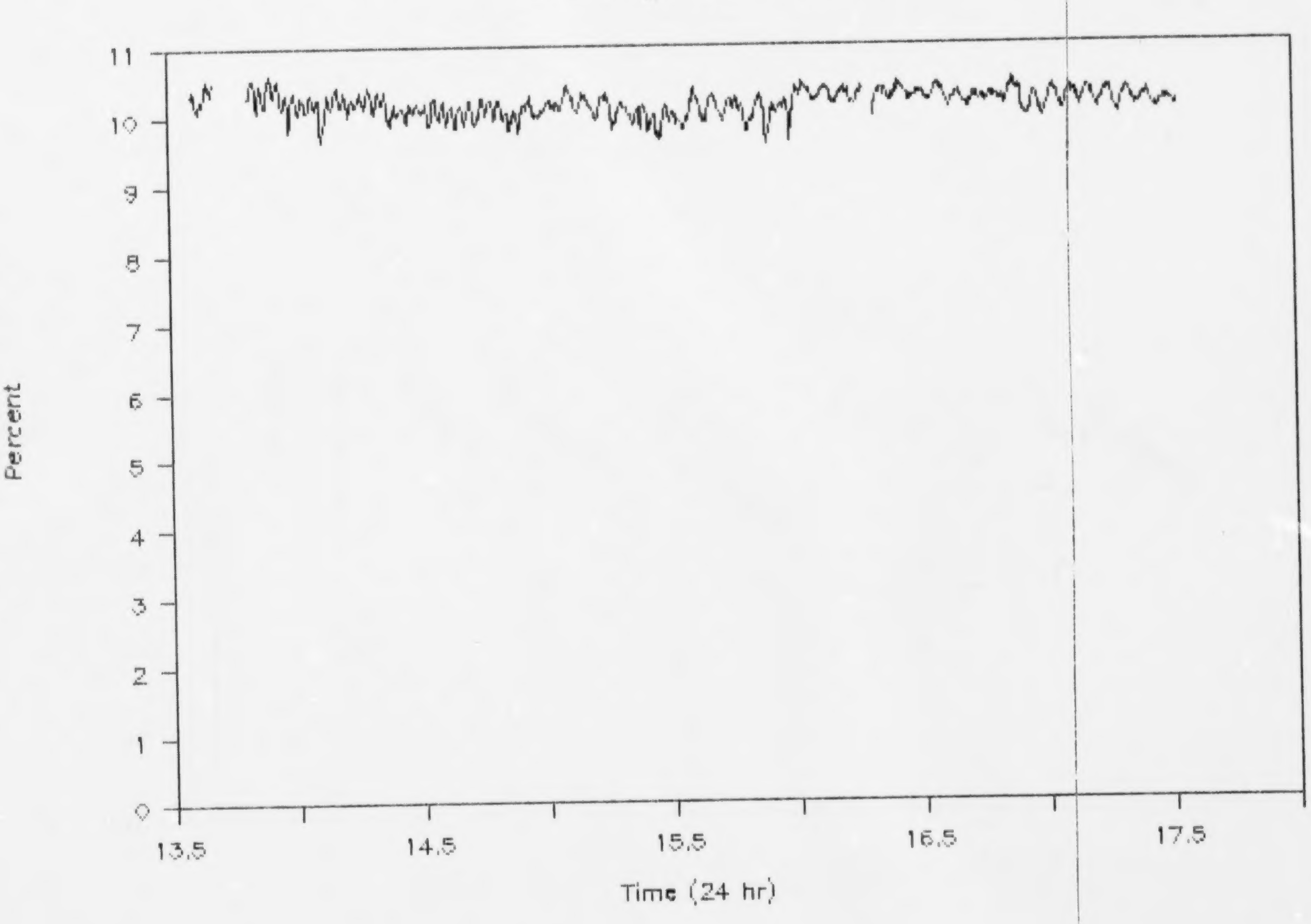
Run #5, THC (Unheated)

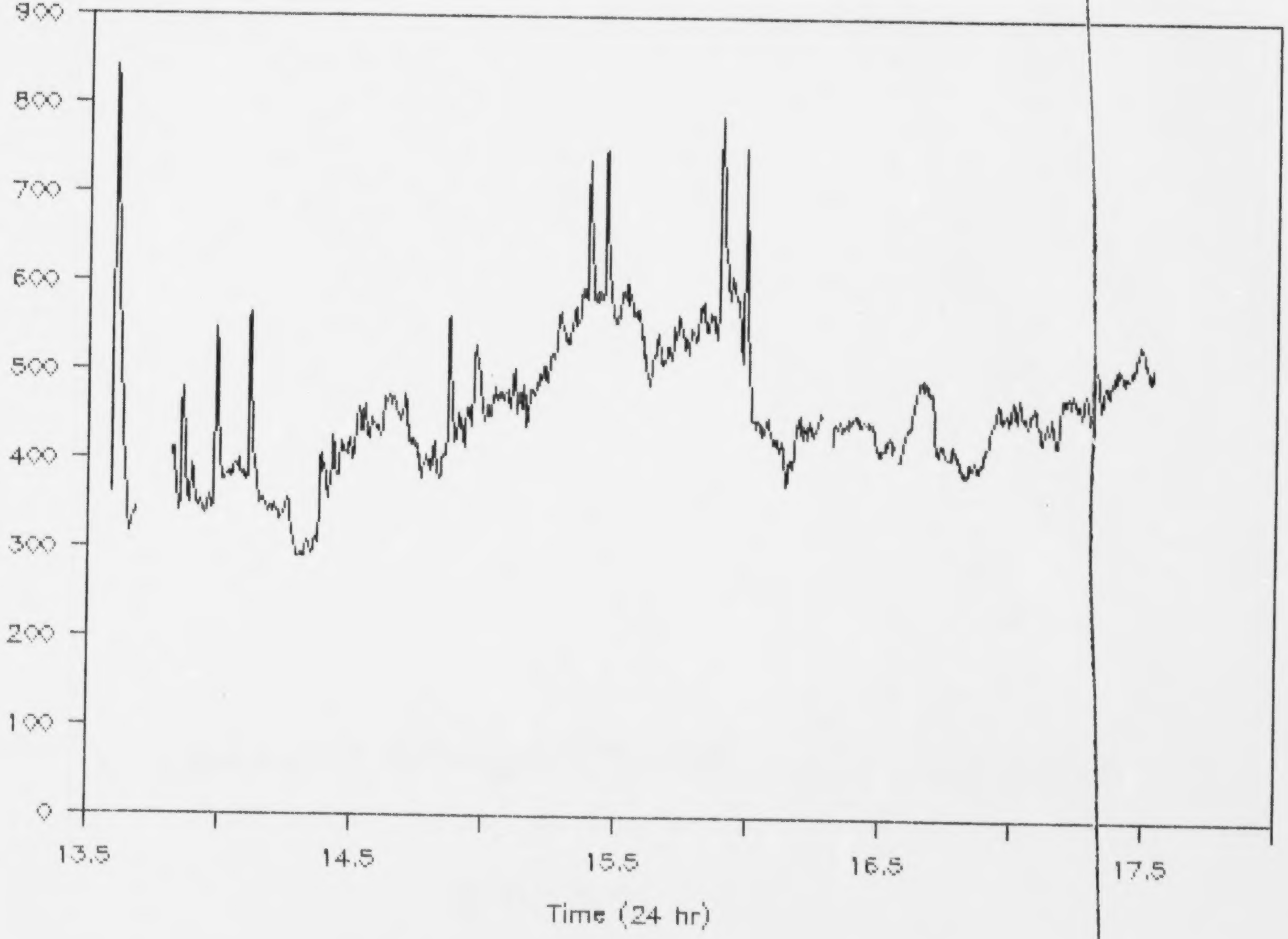


Run #6, CO

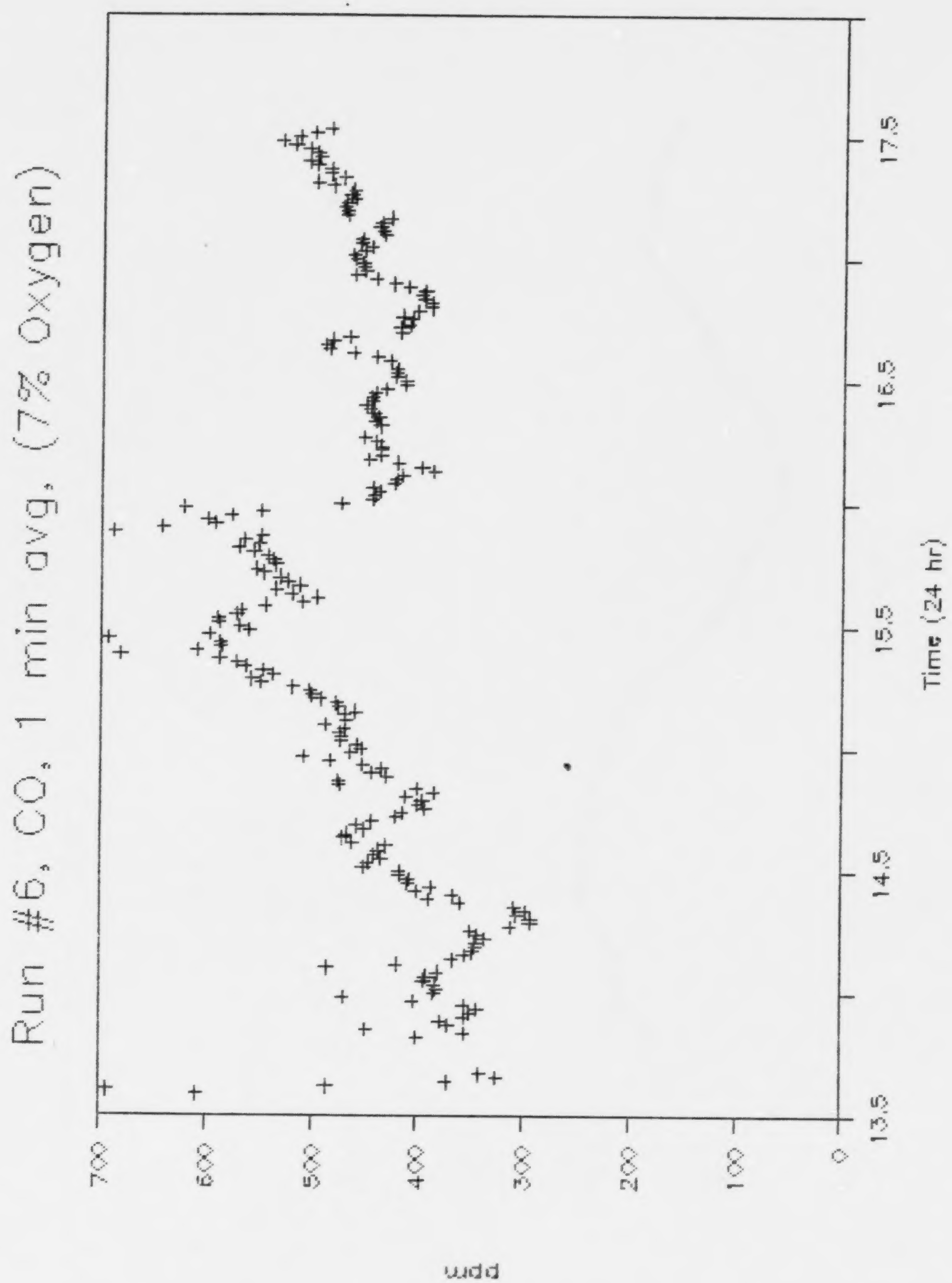

ppm (thousands)
(Thousands)
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
13.5
14.5
15.5
16.5
17.5
Time (24 hr)

Run #6, CO2



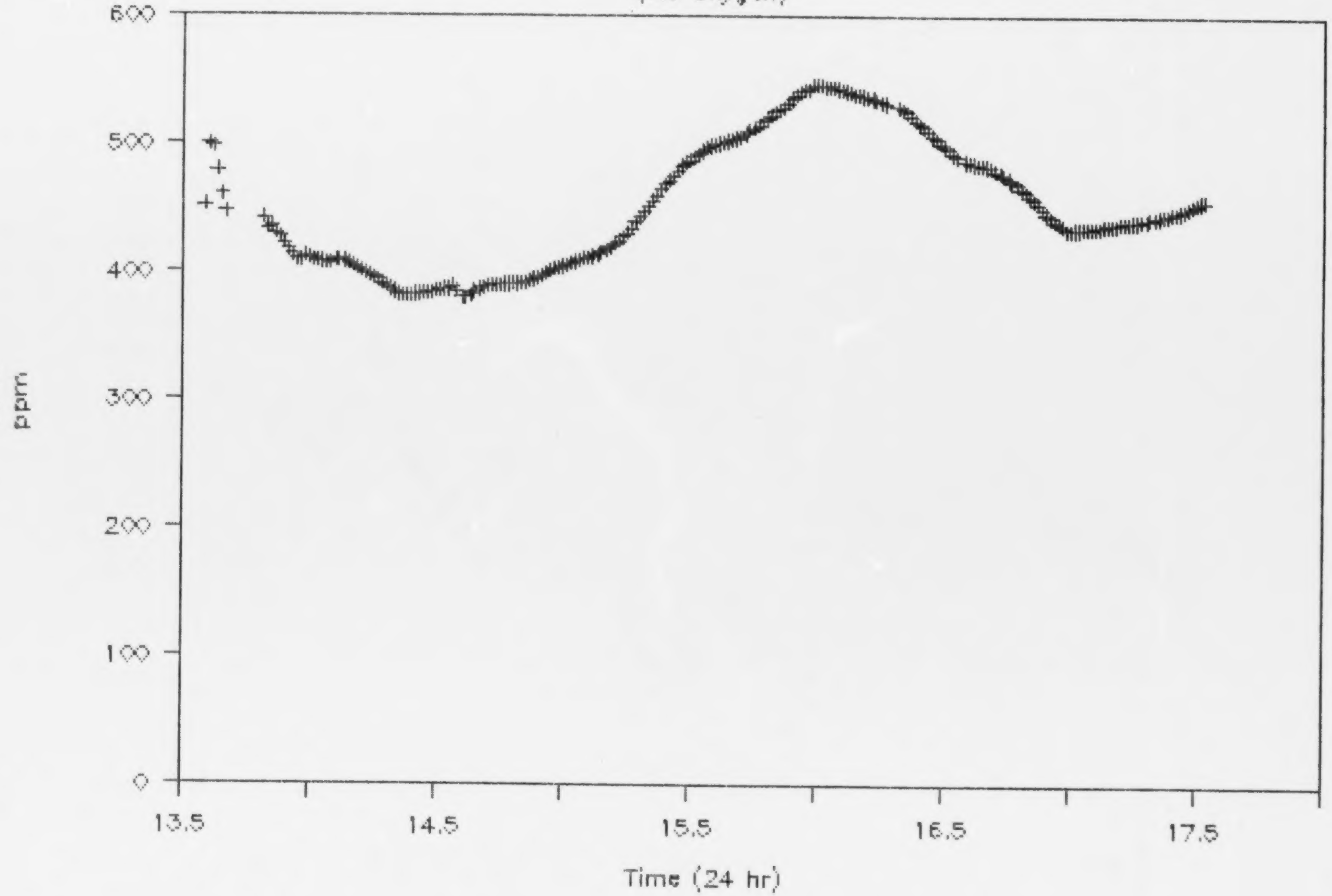


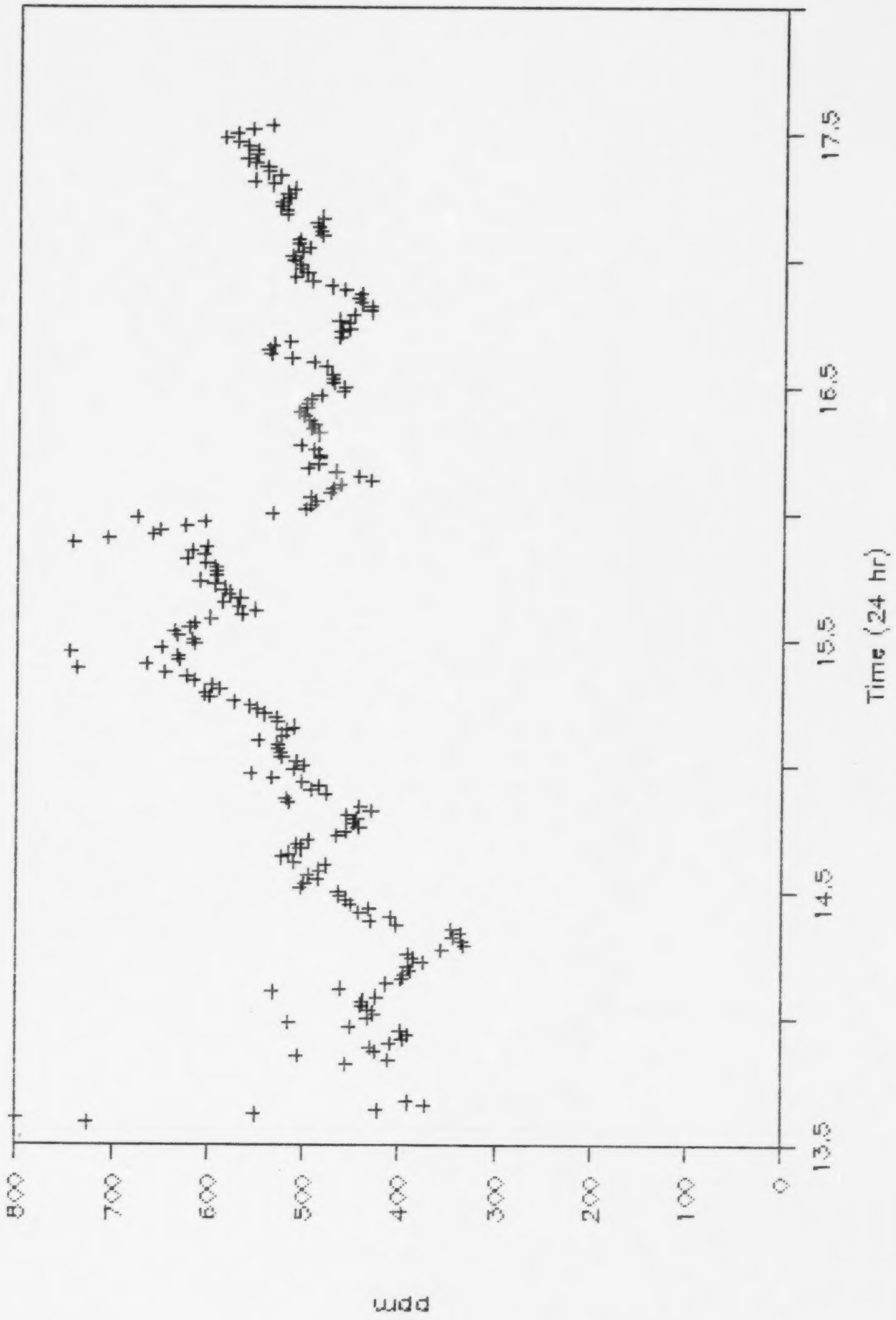
Run #6, CO (7% Oxygen)

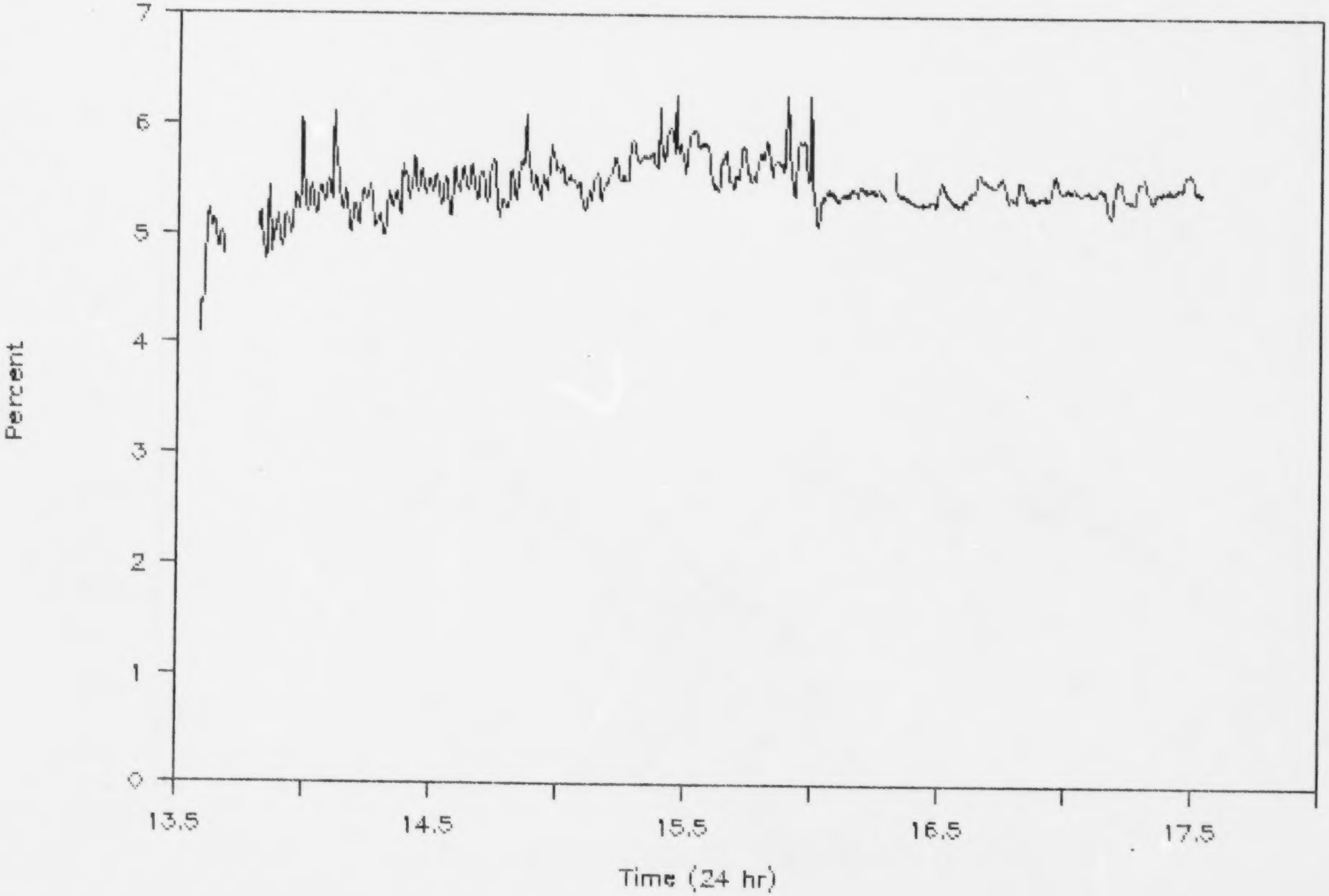

Run #6, CO, 1 min avg, (7% Oxygen)

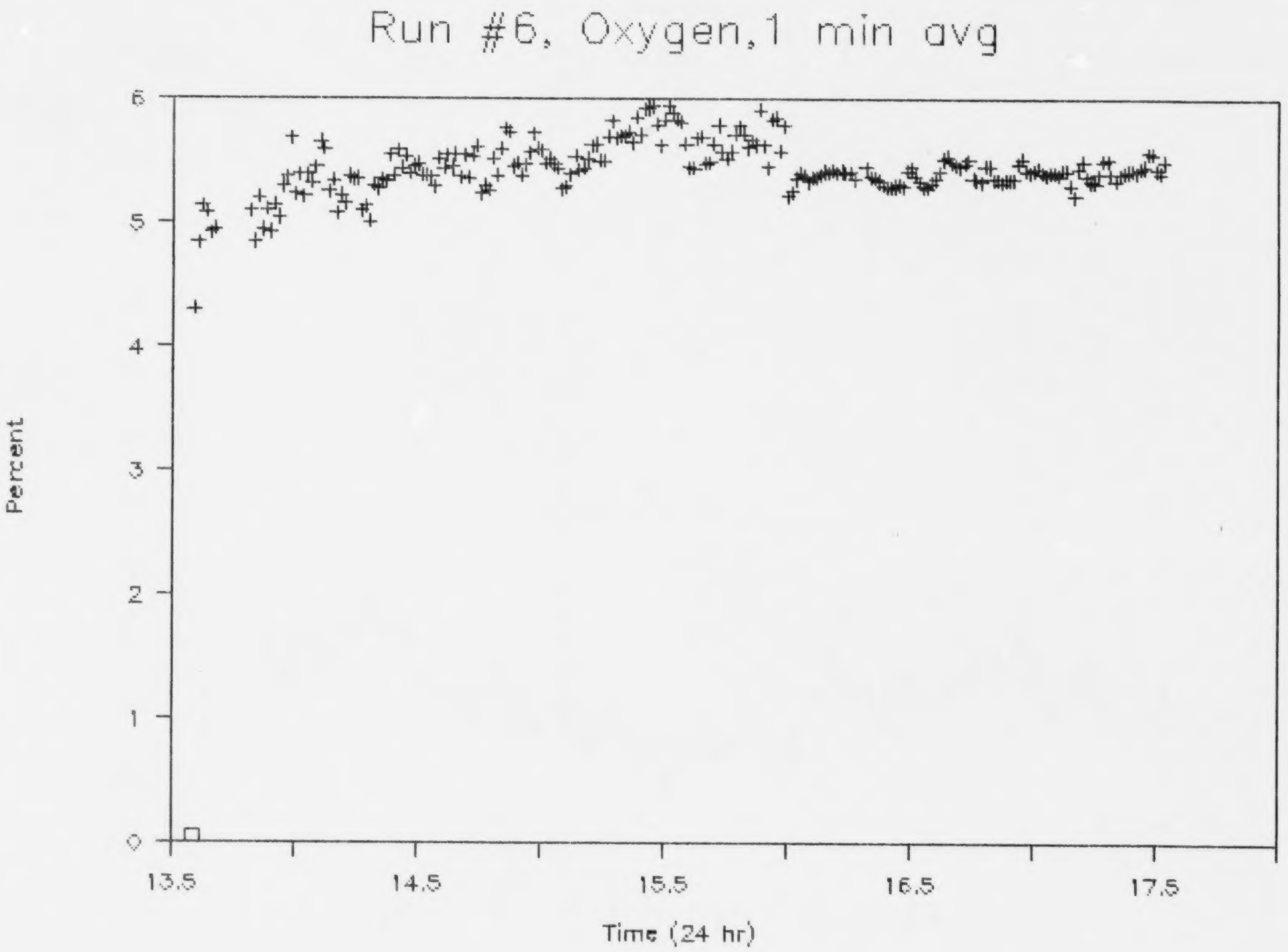
Run #6, CO 1 hr roll. avg.

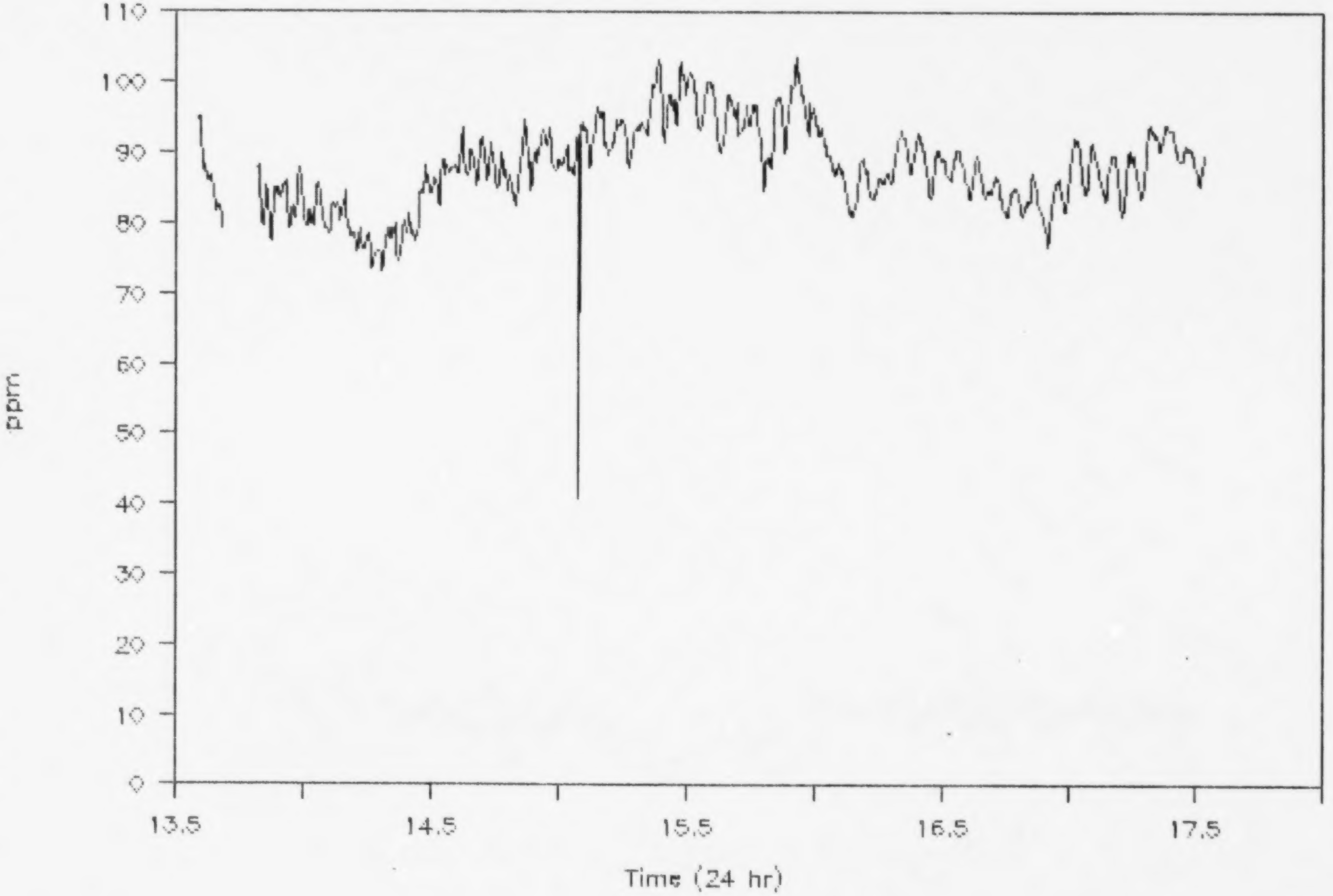
(7% Oxygen)

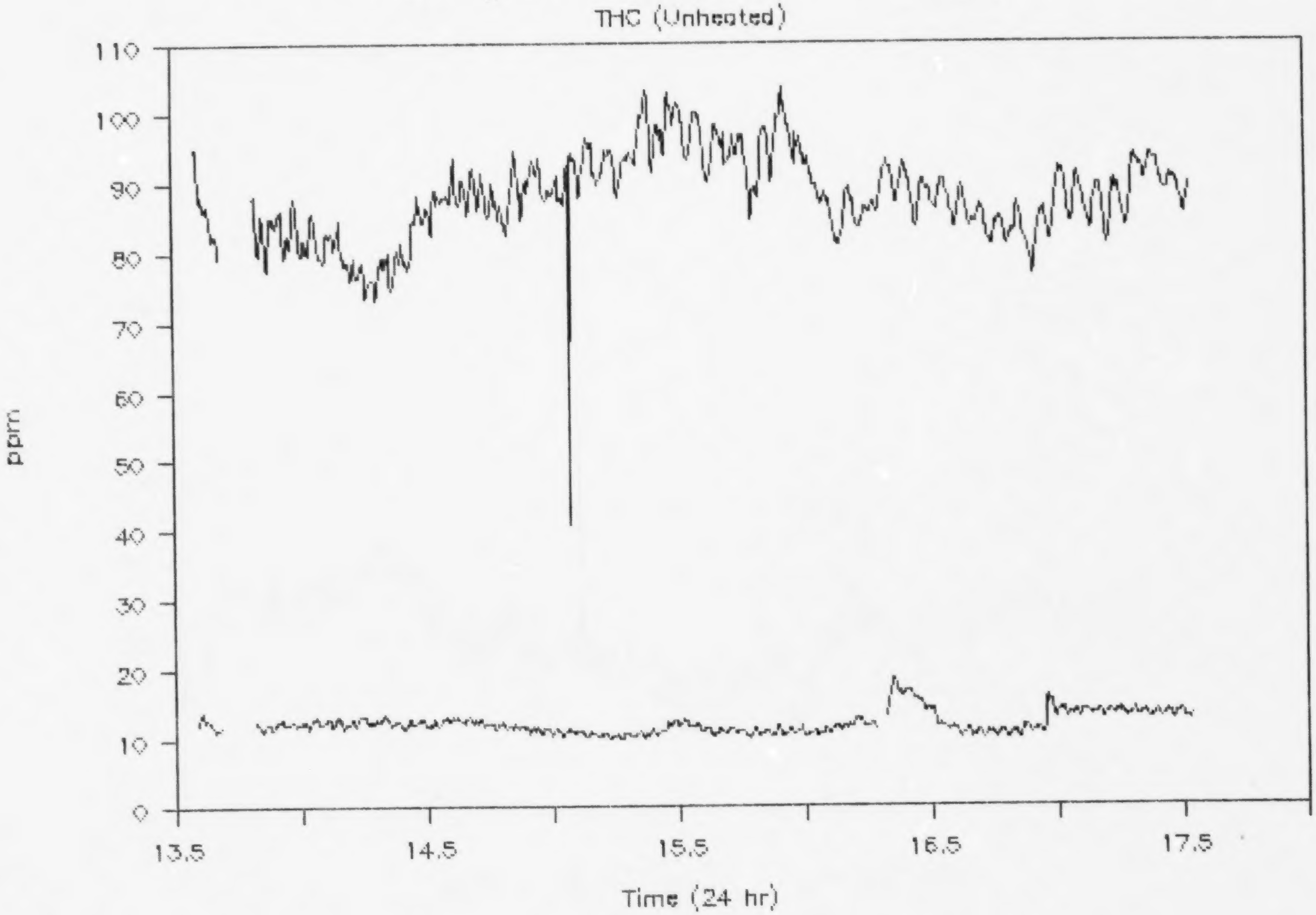



Run #6, CO 1 min avg
800
700
600
500
400
300
200
100
0
ppm
13.5
14.5
15.5
16.5
17.5
Time (24 hr)

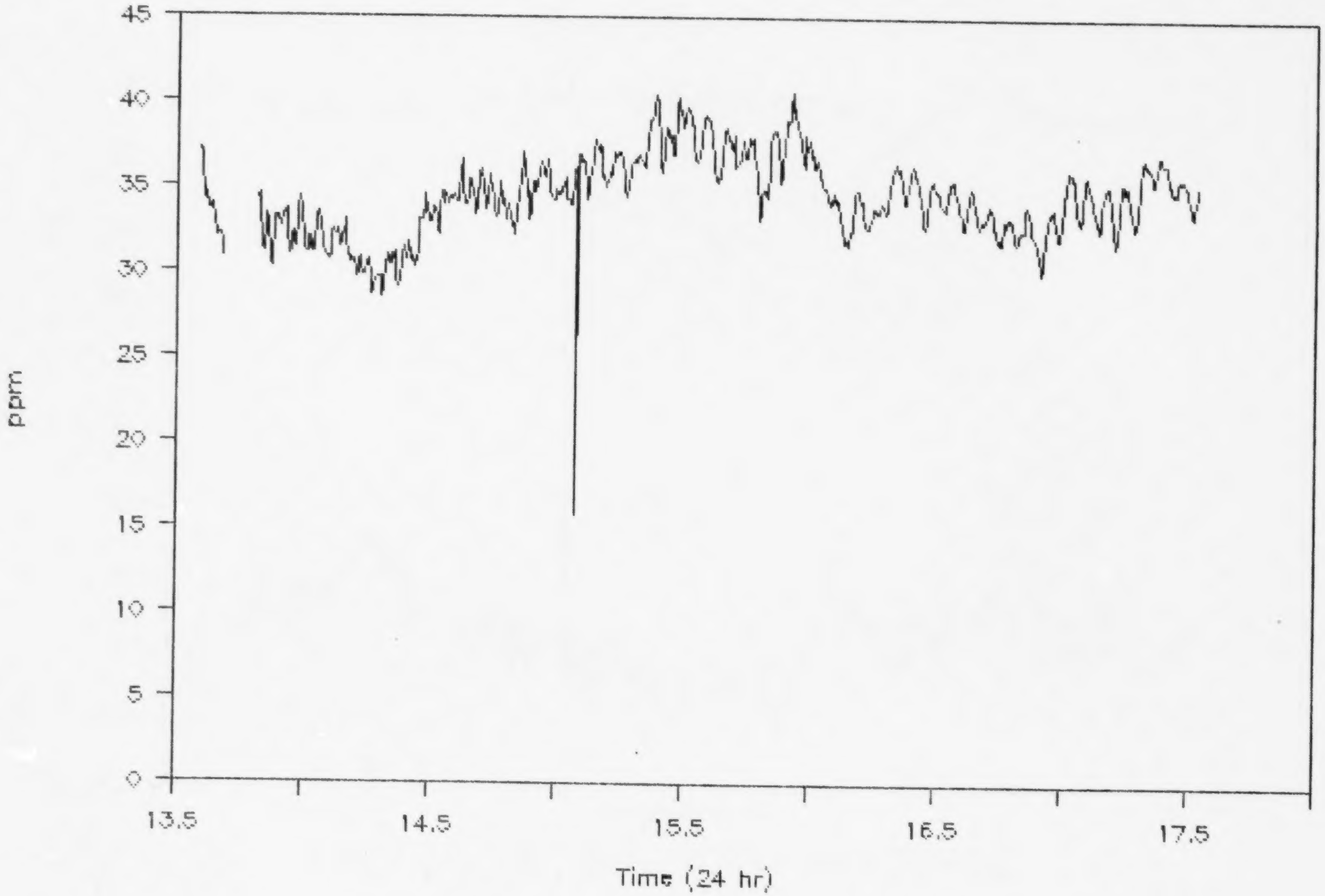

Run #6, Oxygen


Run #6, Oxygen,1 min avg
Percent
6
5
4
3
2
1
0
13.5
14.5
15.5
16.5
17.5
Time (24 hr)

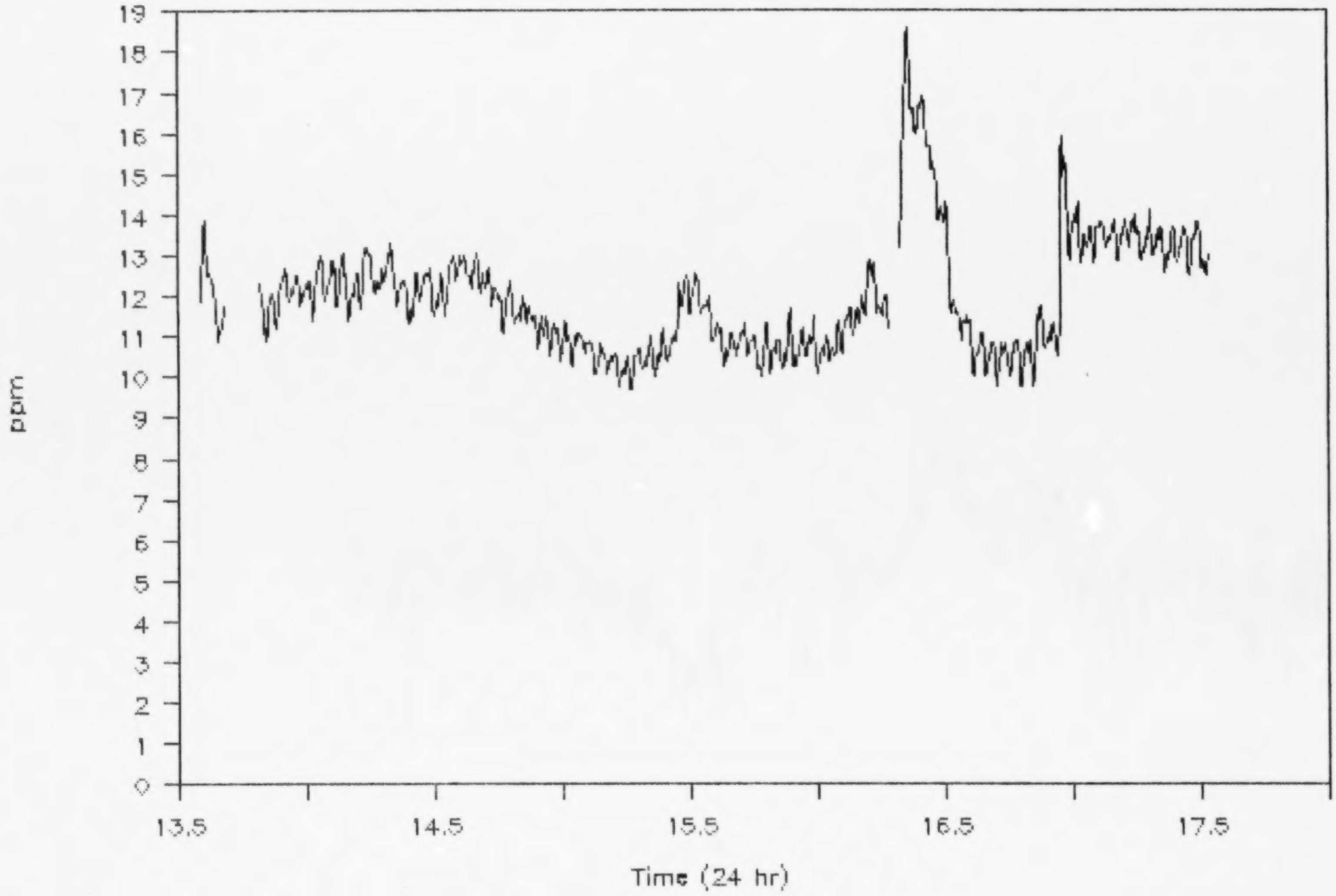

Run #6, dry THC (heated)

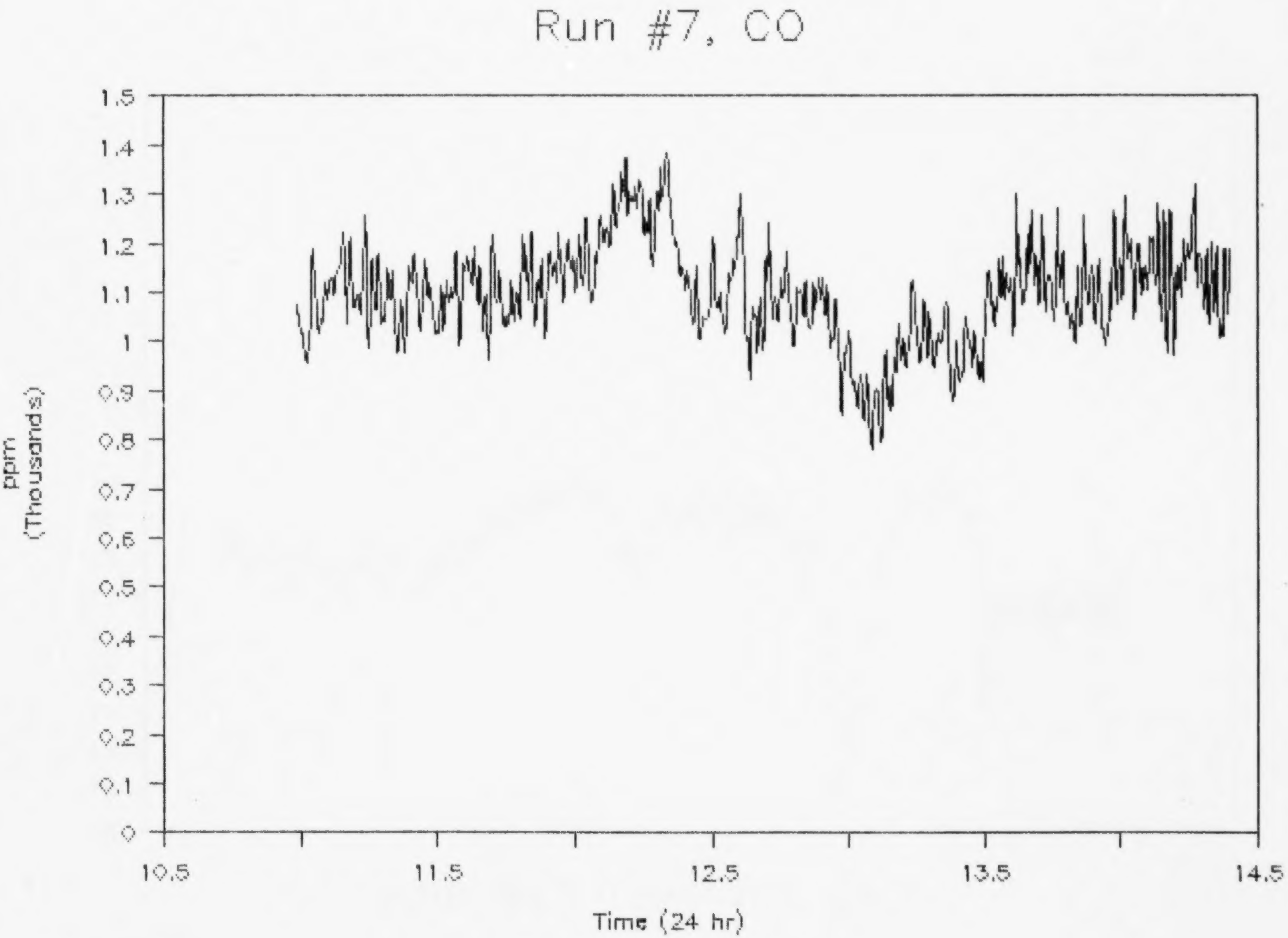

Run #6, THC (dry, heated)

Run #6, THC (heated)

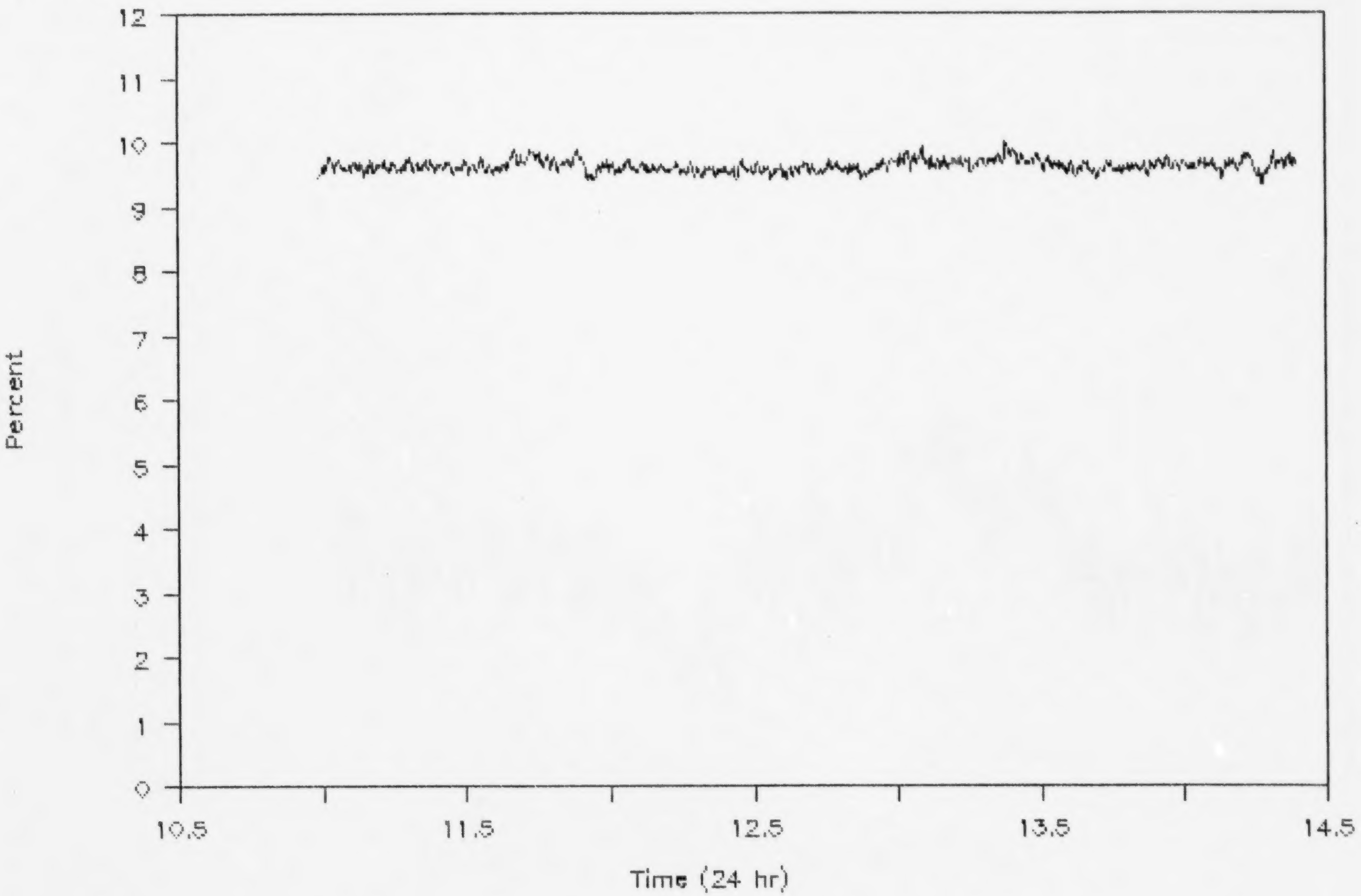


Run #6, unheated THC

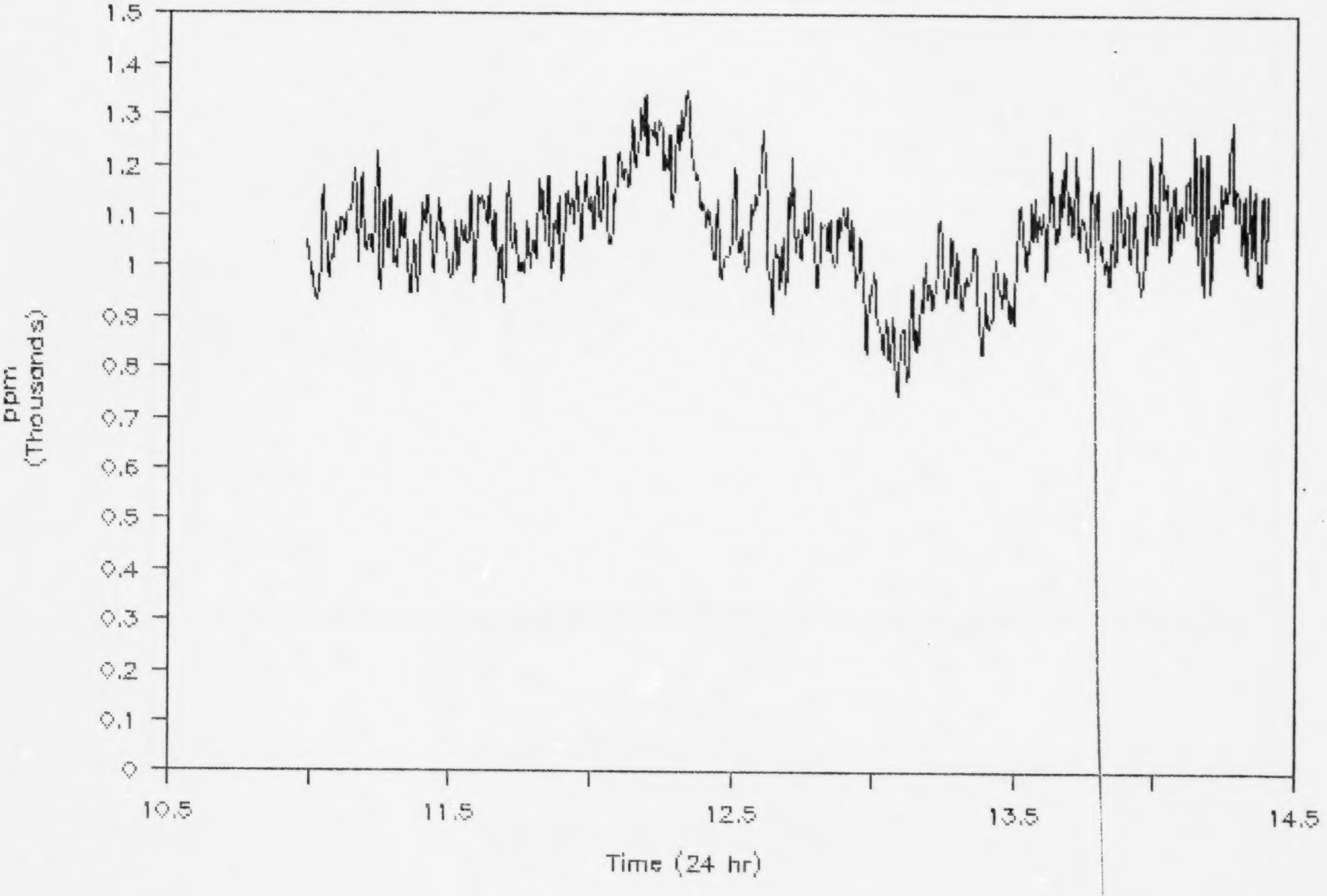



Run #7, CO
ppm
(Thousands)
1.5
1.4
1.3
1.2
1.1
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
10.5
11.5
12.5
13.5
14.5
Time (24 hr)

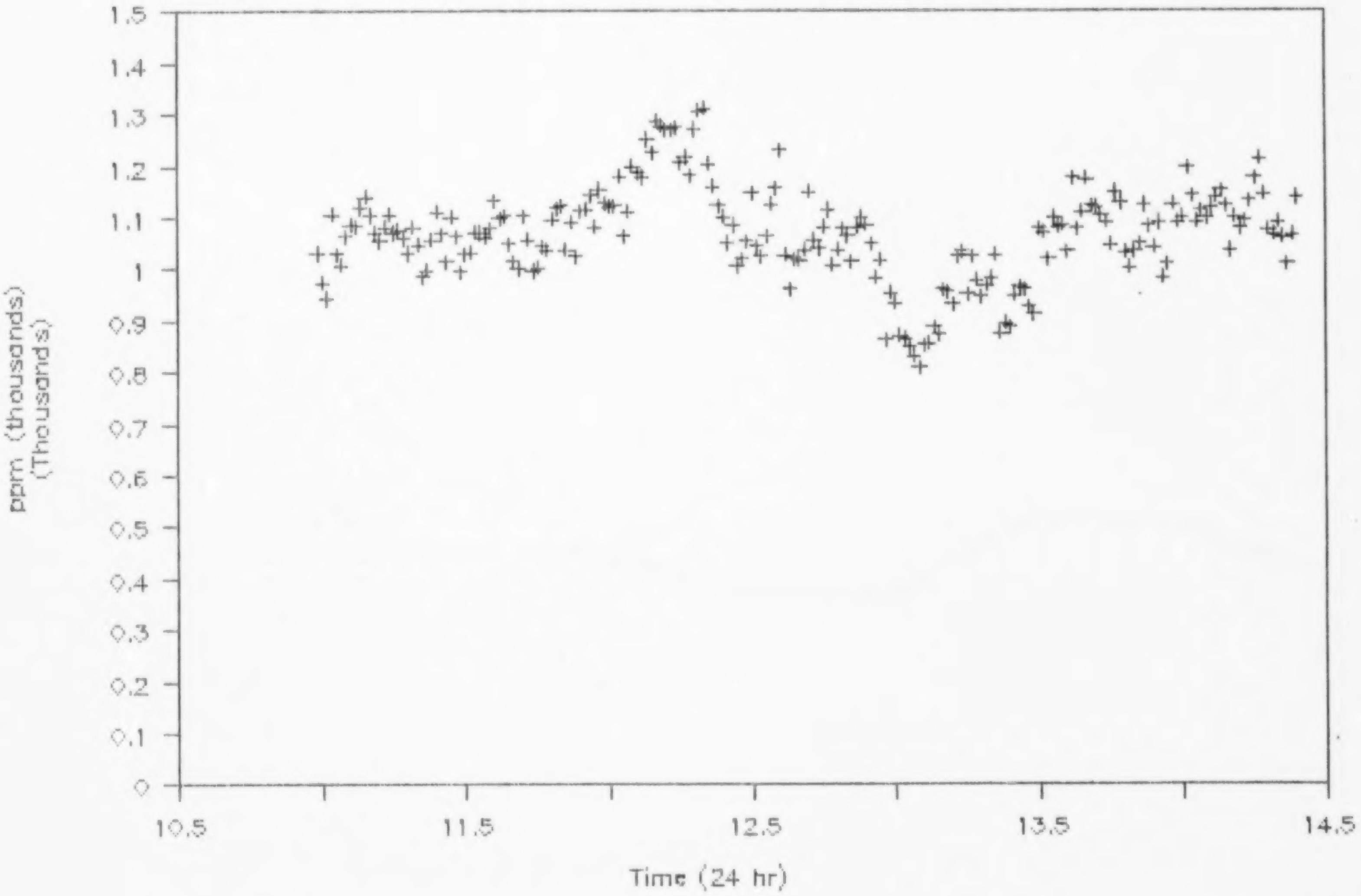
Run #7, CO2

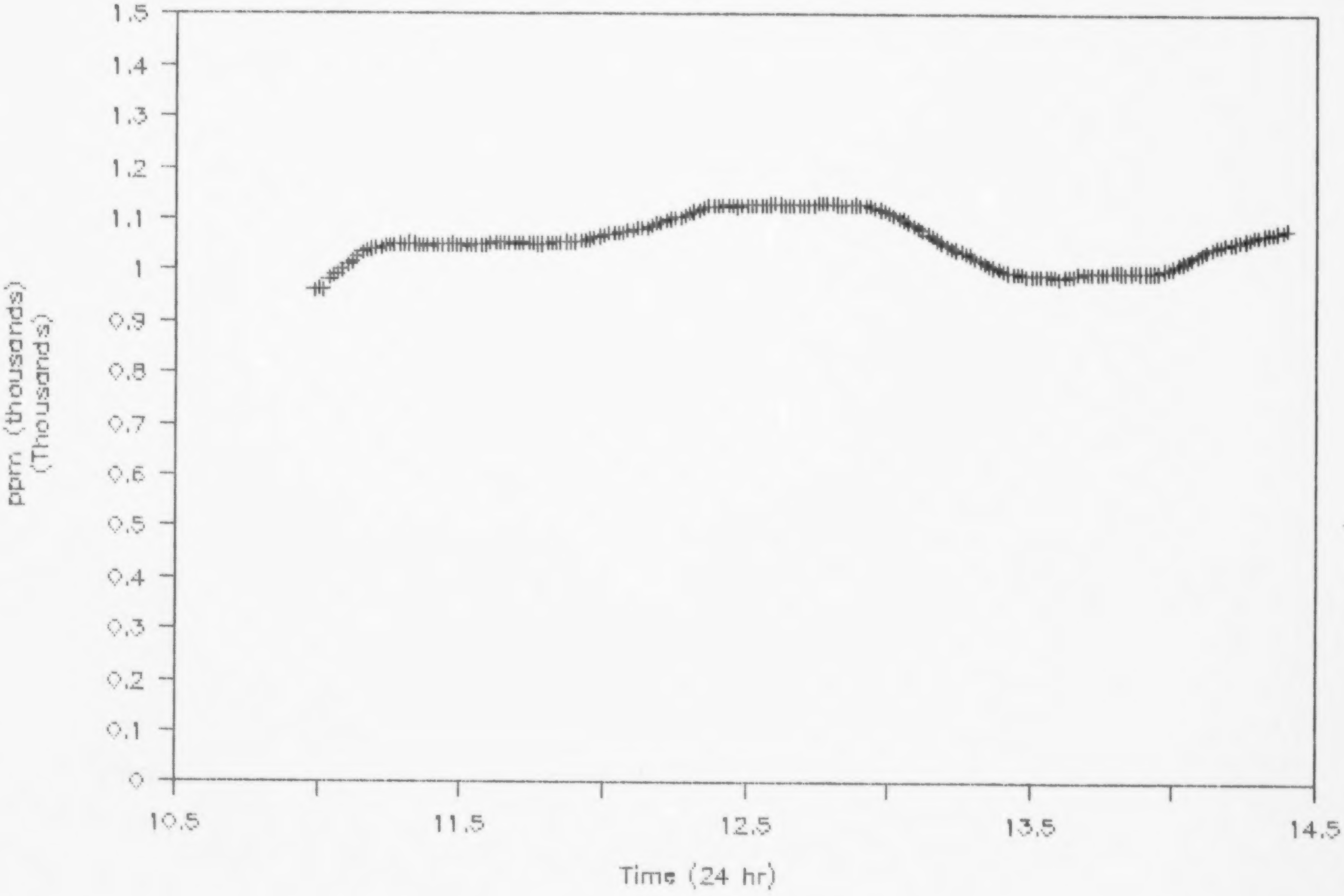


Run #7, CO (7% Oxygen)

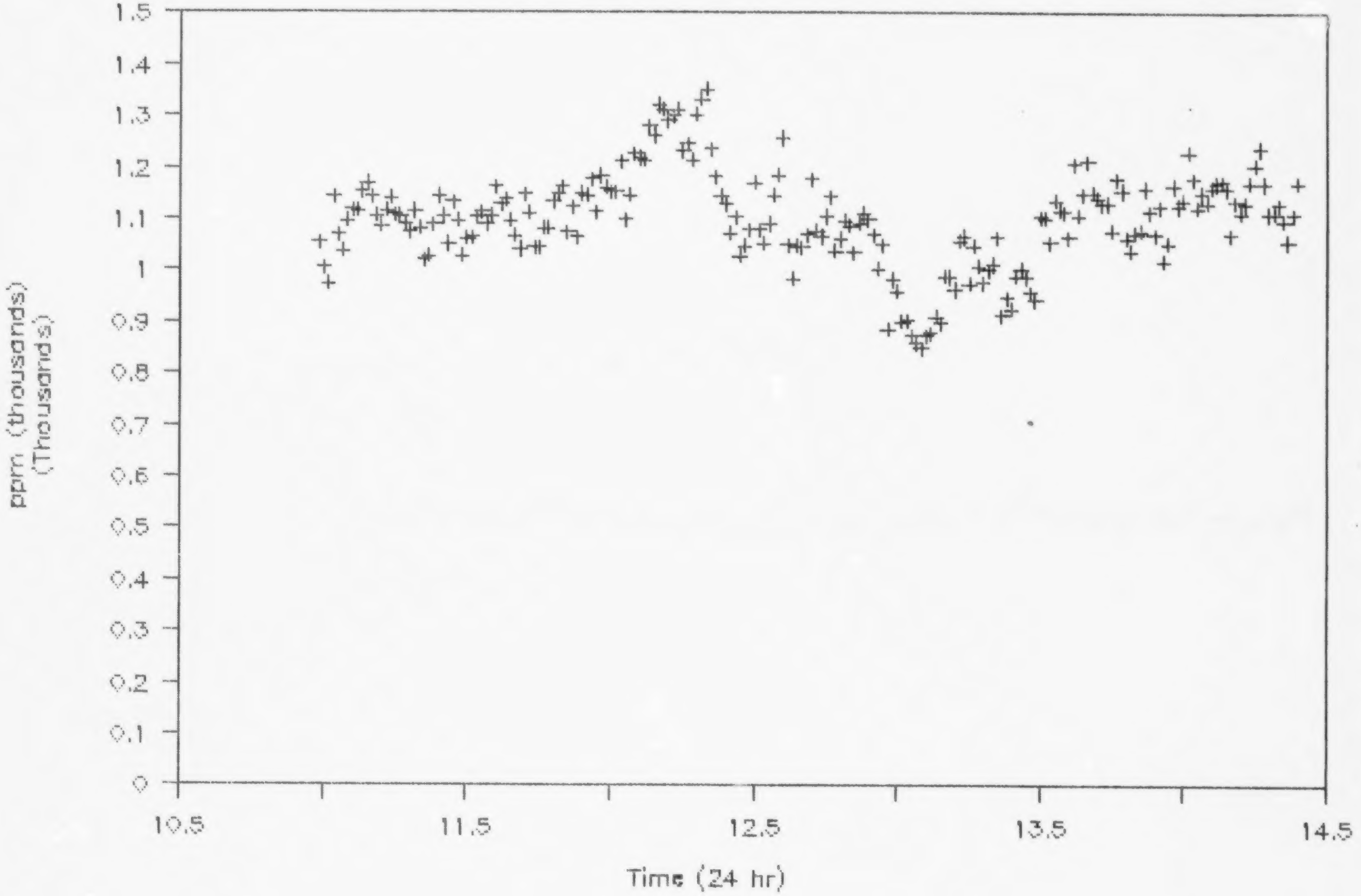


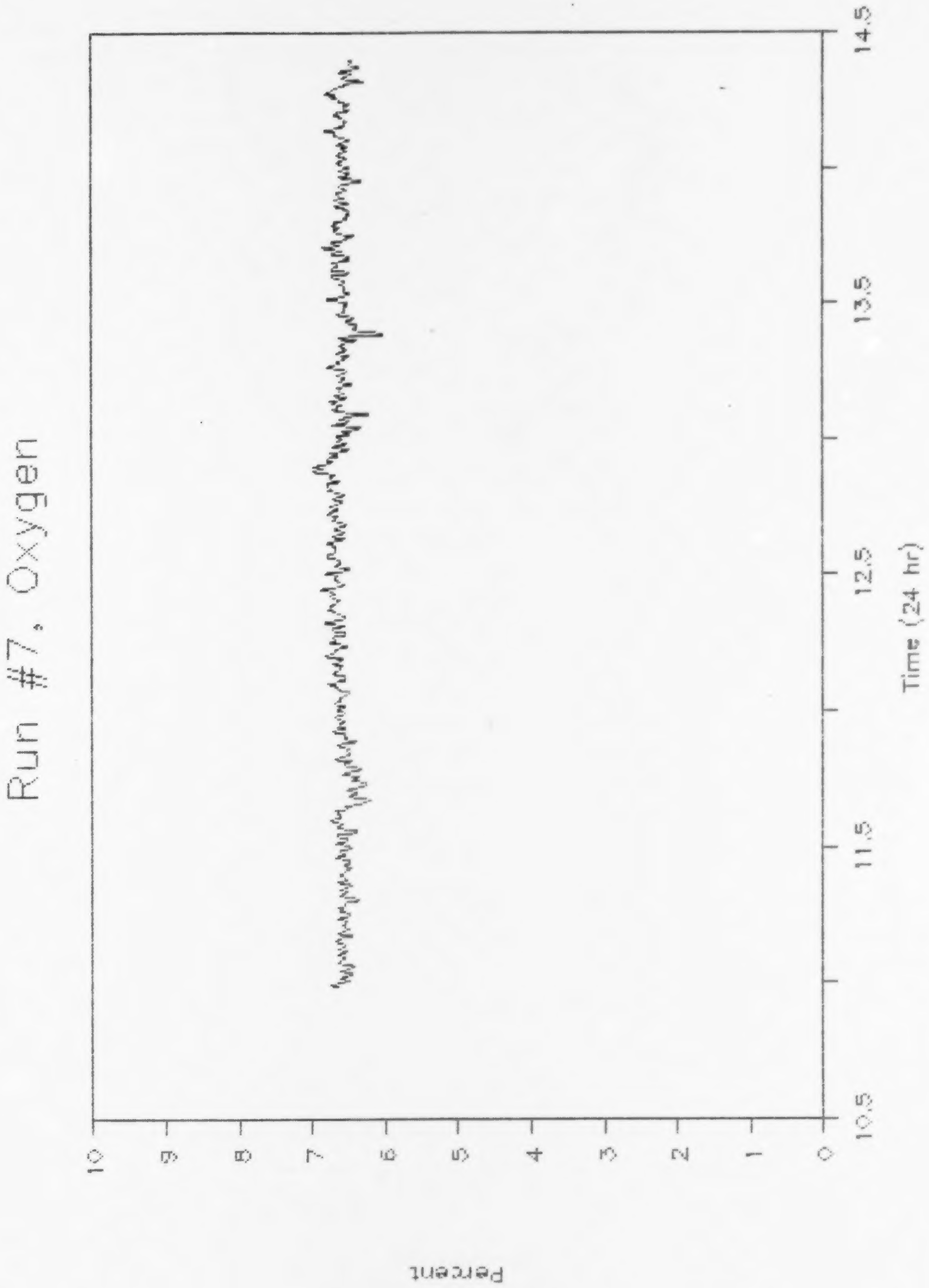
Run #7, CO (7% Oxygen), 1 min avg.




Run #7, CO (7% Oxygen), 1 hr roll avg.

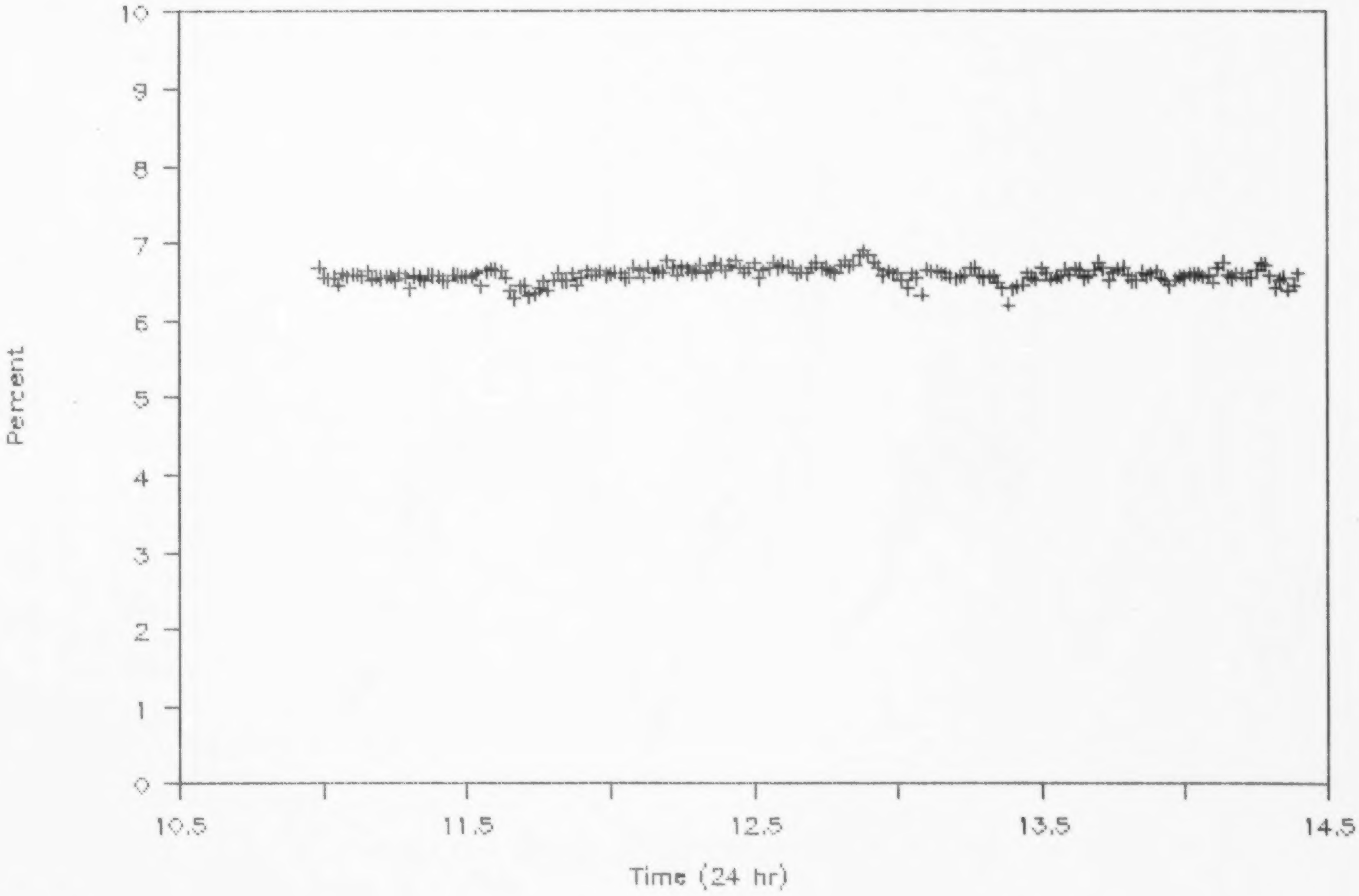
Run #7, CO, 1 min avg.



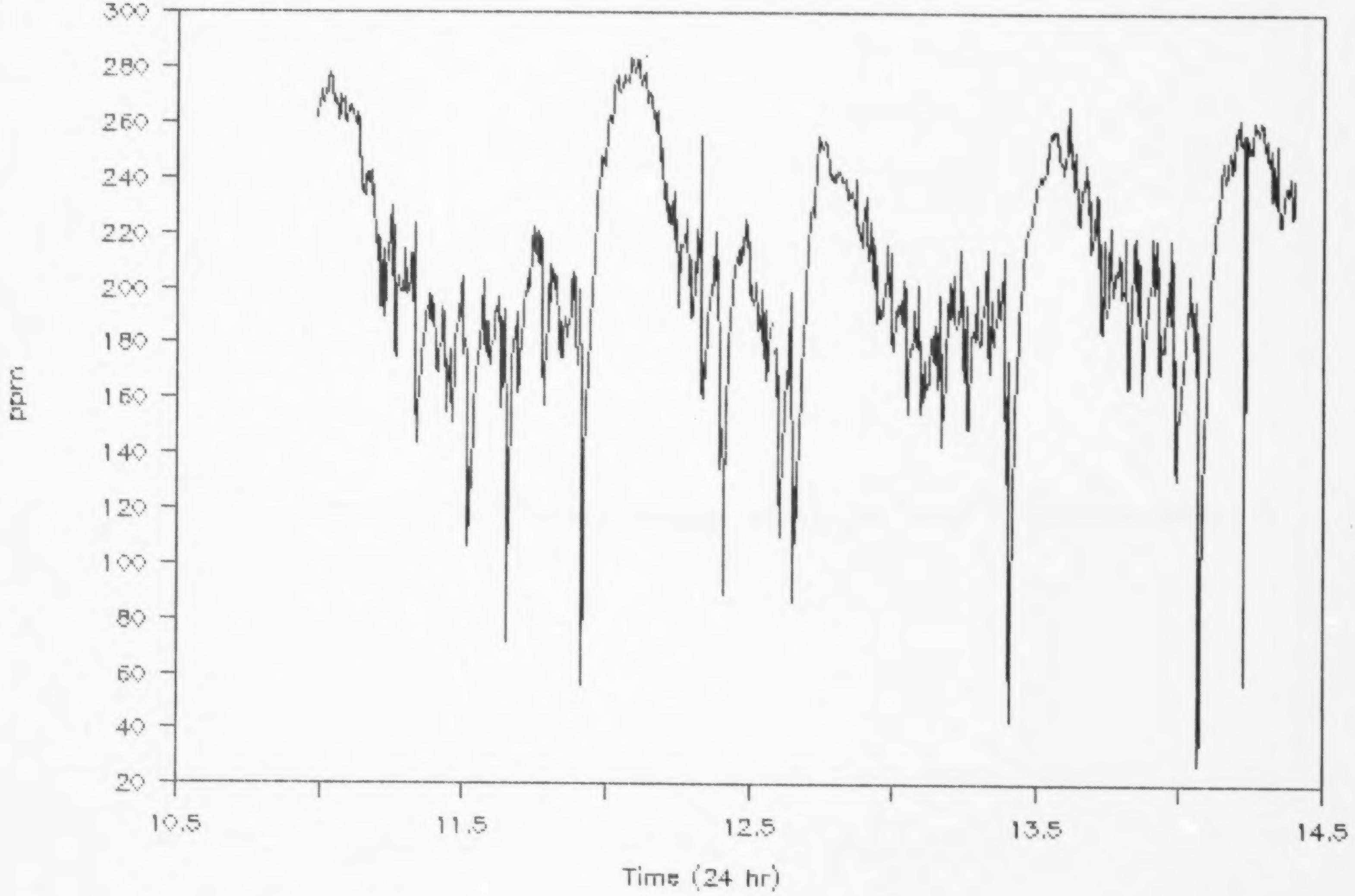


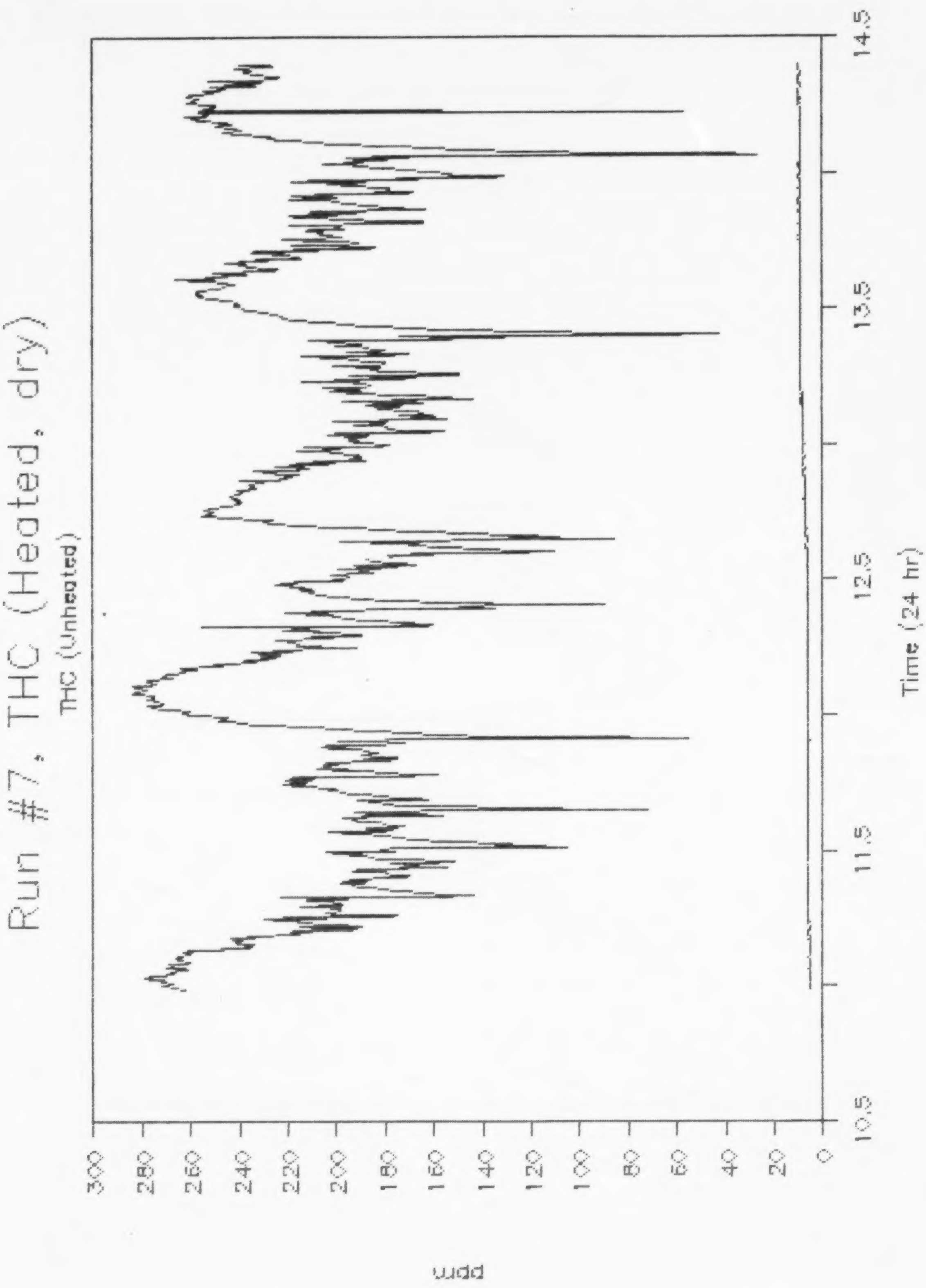
Run #7, Oxygen
Percent
0
1
2
3
4
5
6
7
8
9
10
Time (24 hr)
10.5
11.5
12.5
13.5
14.5

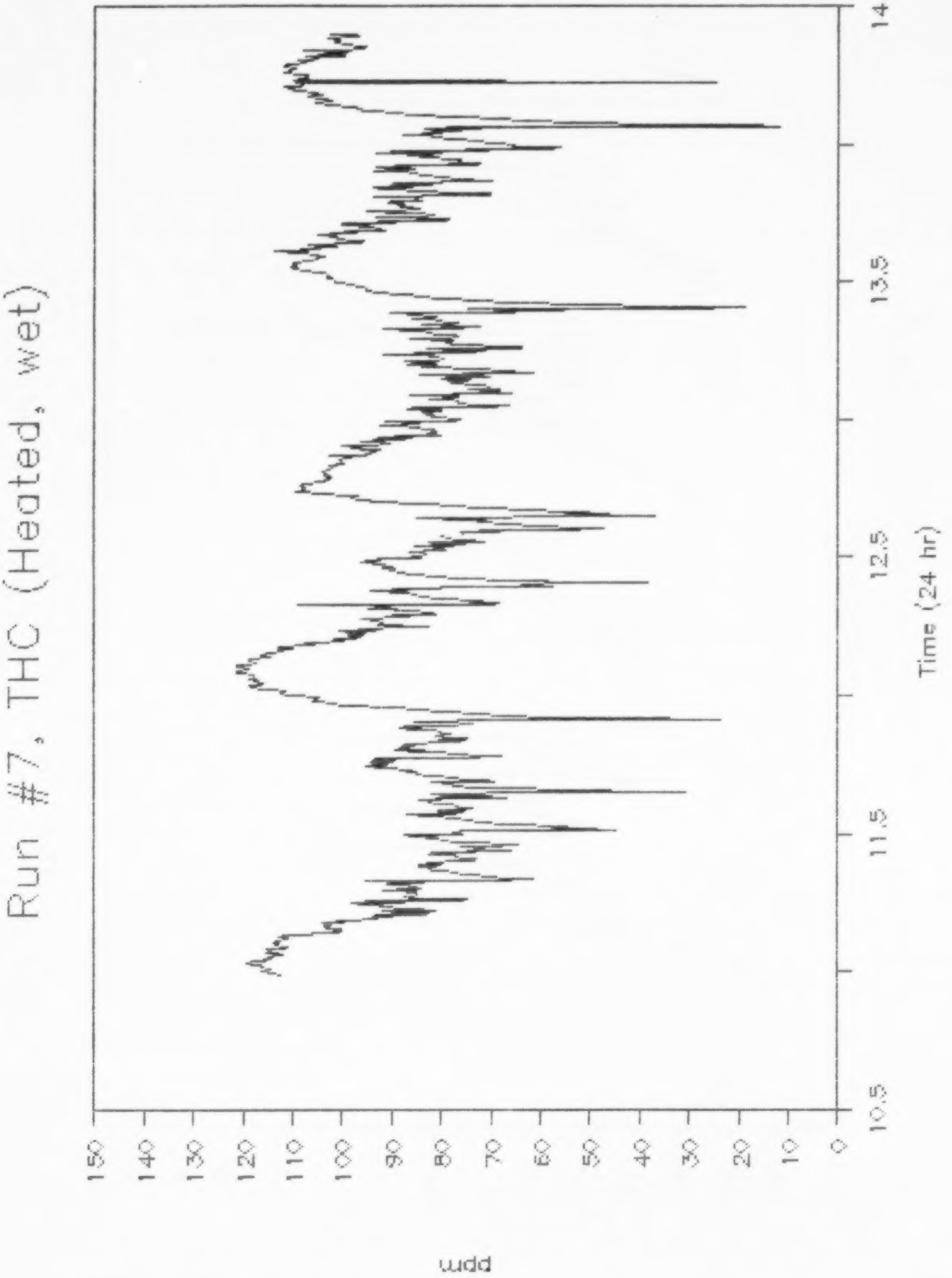
Run #7, Oxygen, 1 min avg.



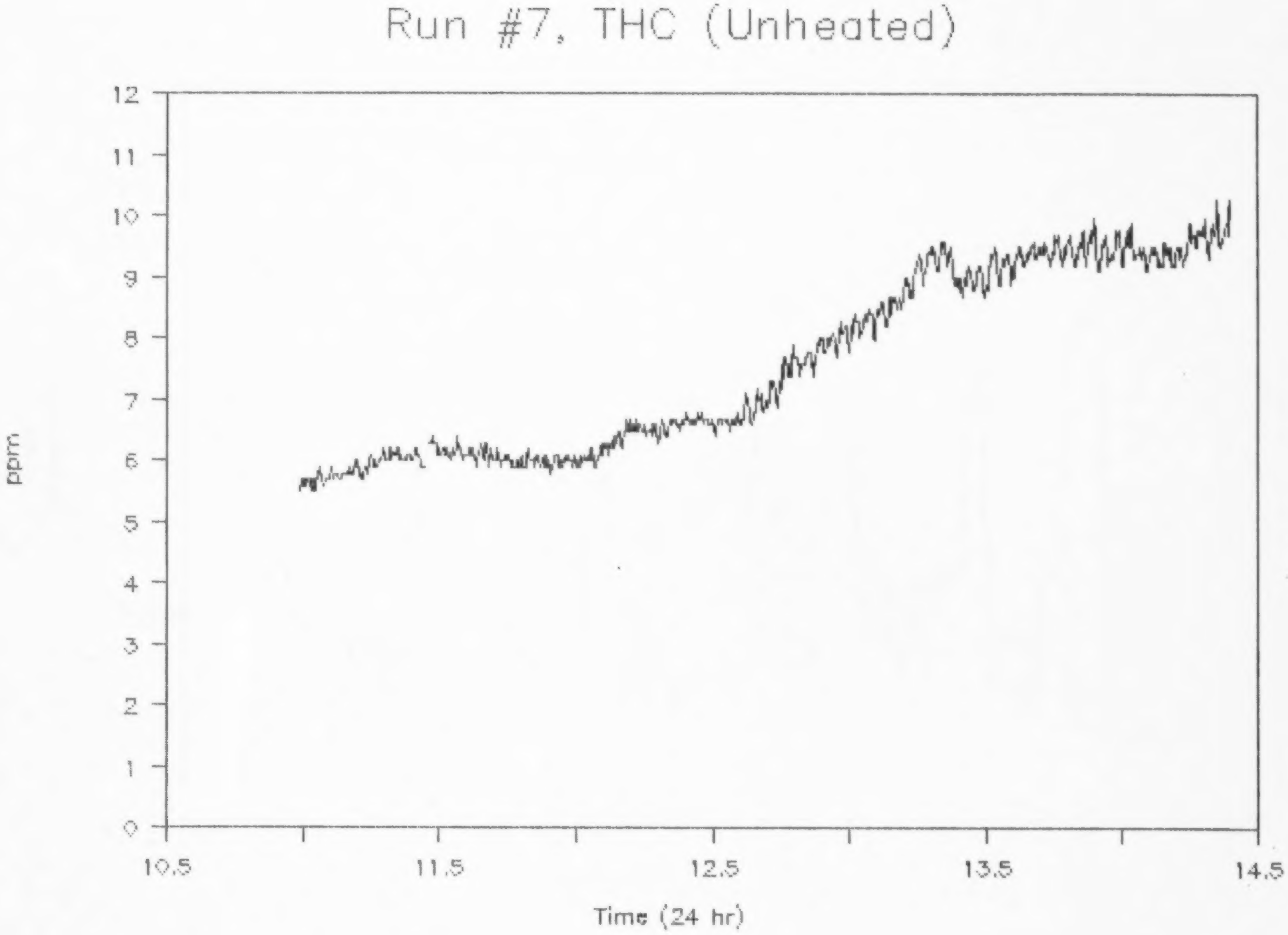
Run #7, THC (Heated, dry)




Run #7, THC (Heated, dry)
THC (Unheated)
ppm
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
10.5
11.5
12.5
13.5
14.5
Time (24 hr)

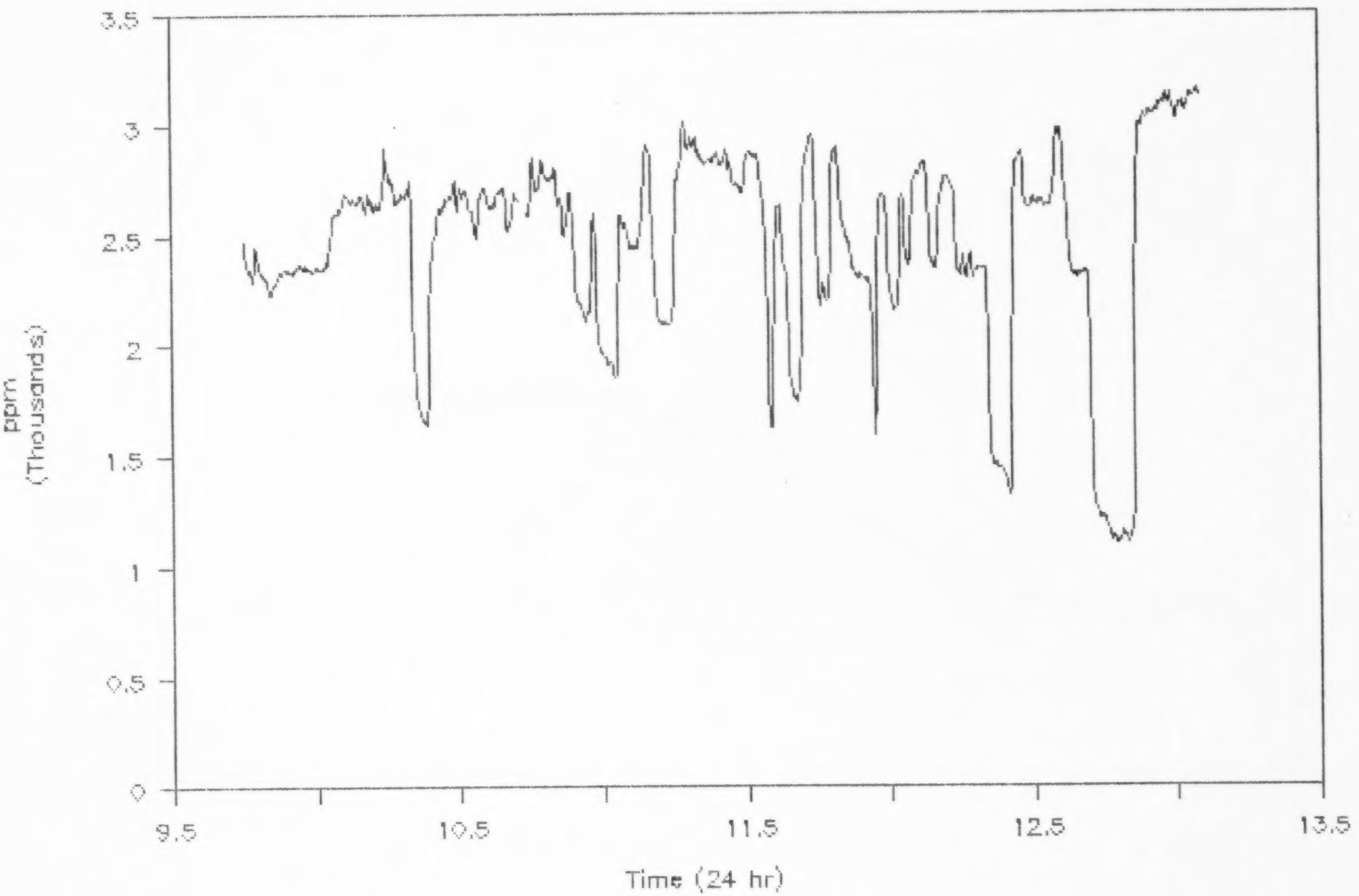


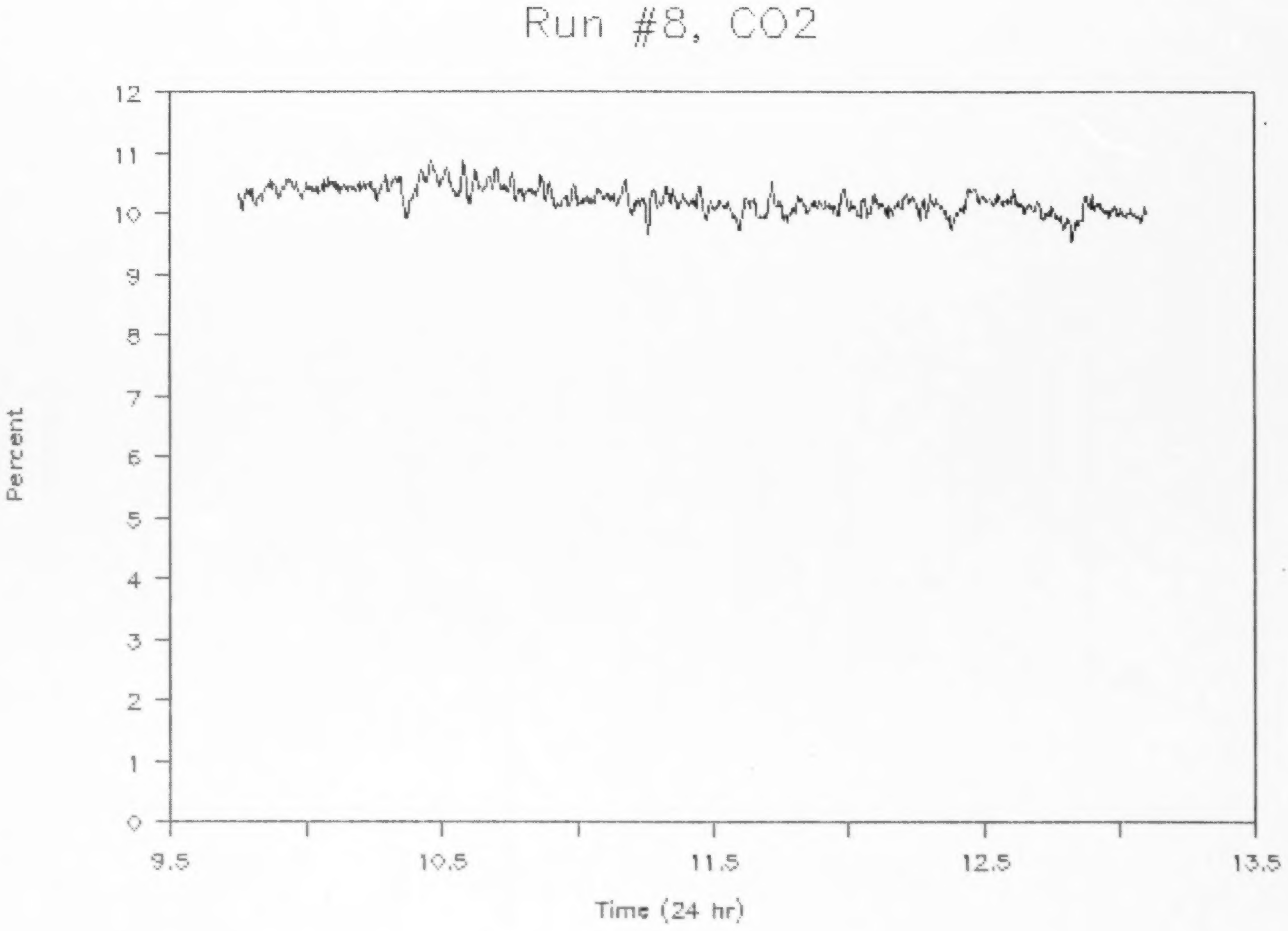
Run #7, THC (Heated, wet)



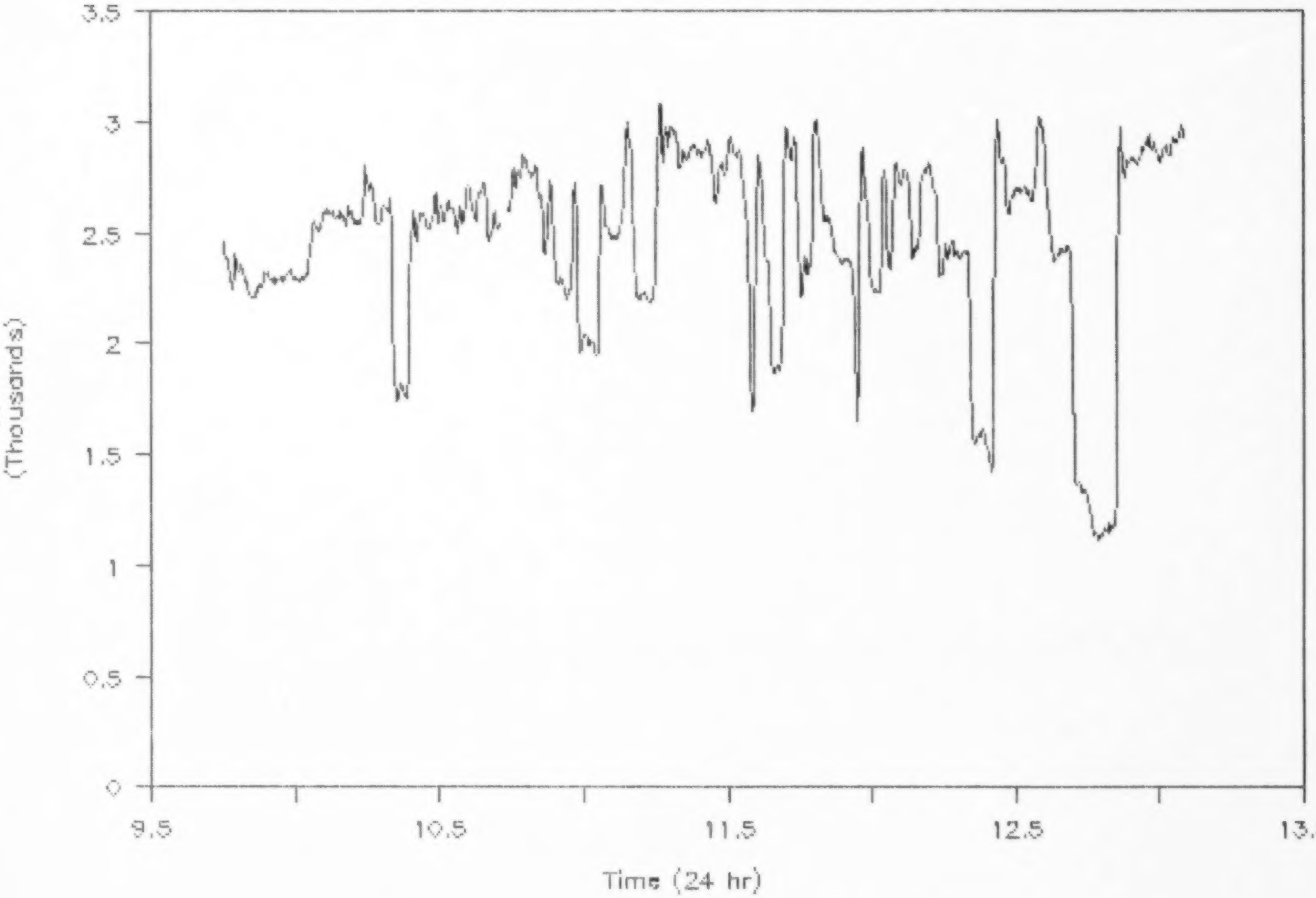
Run #7, THC (Unheated)

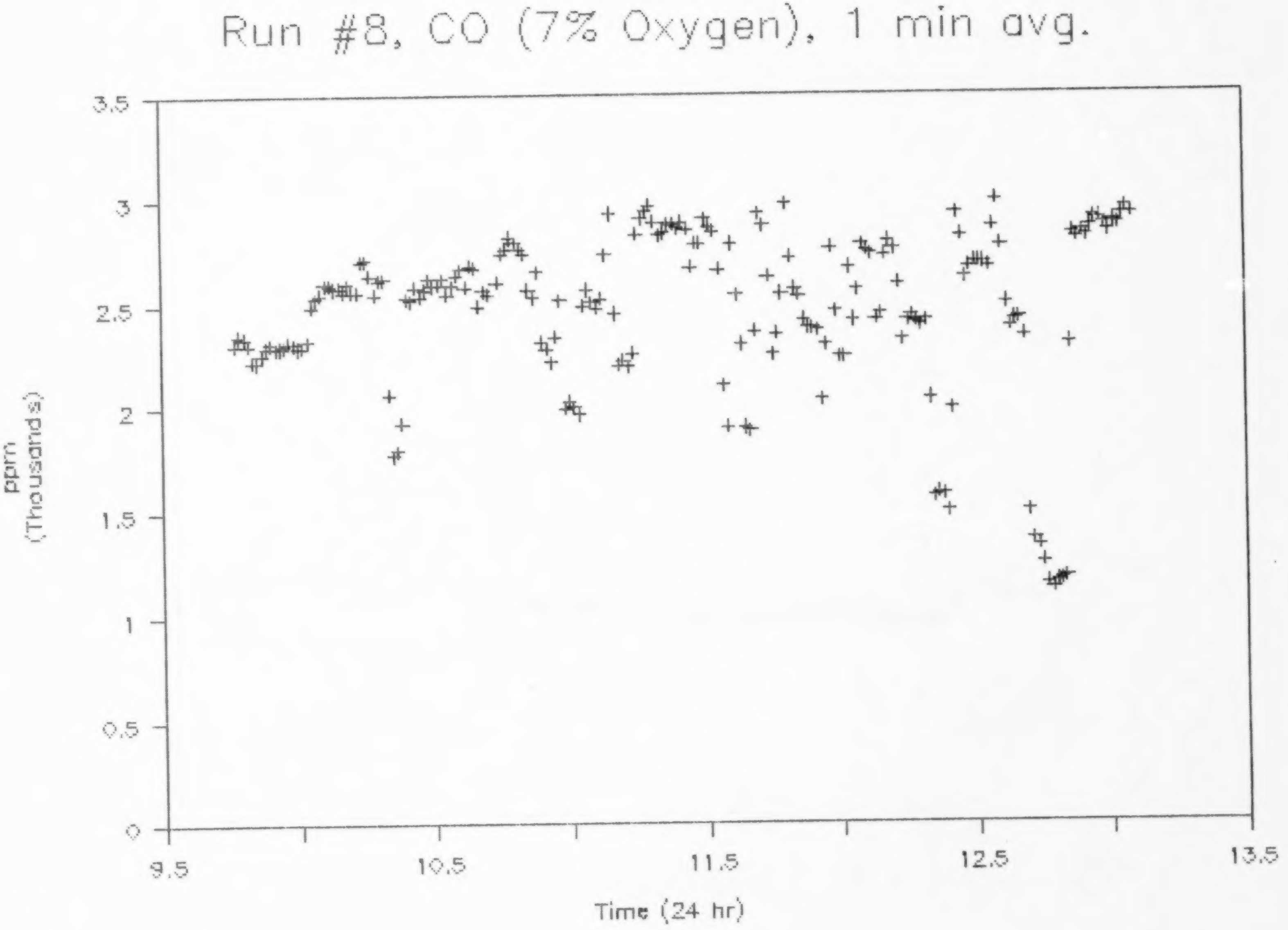
Run #8, CO



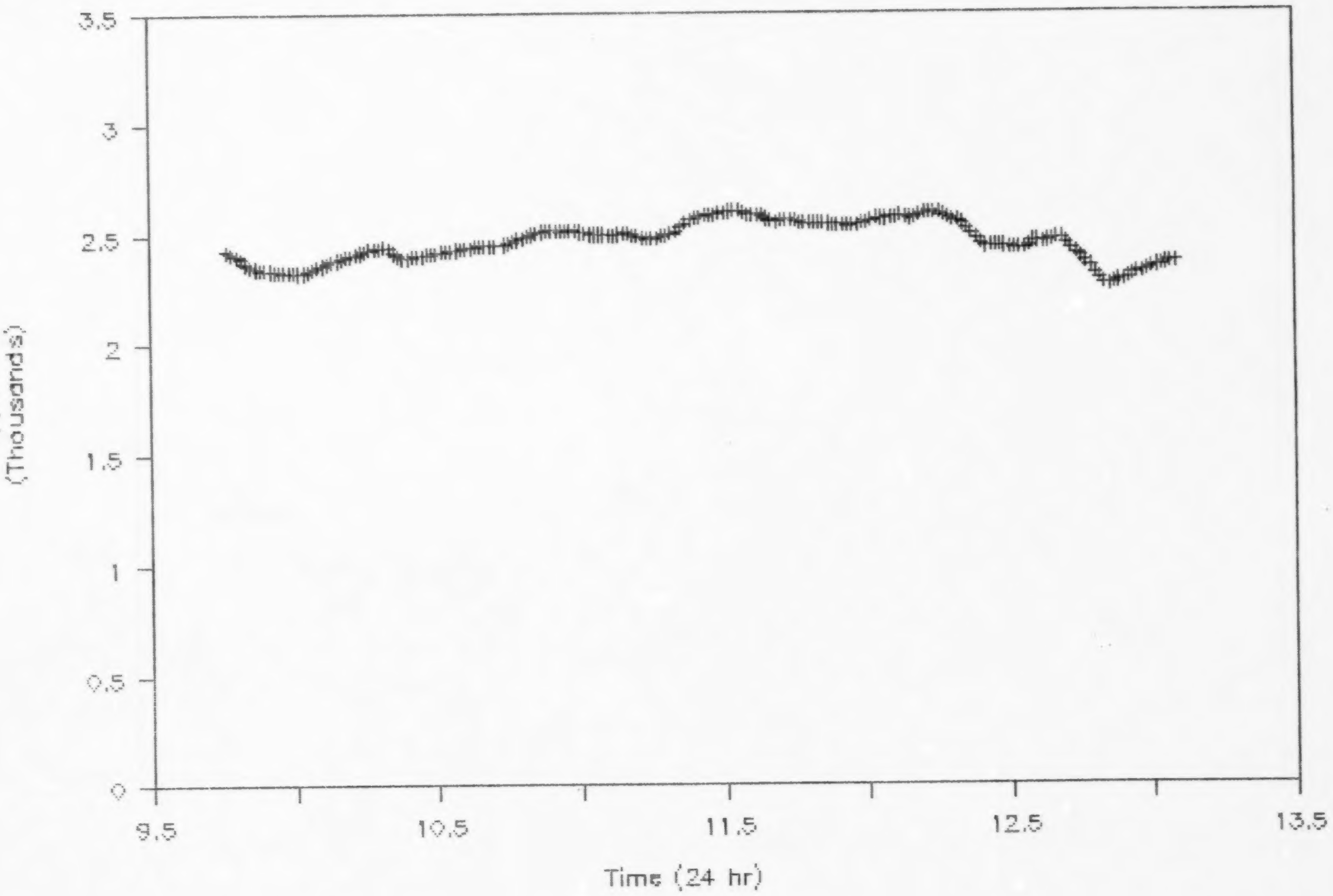

Run #8, CO2
Percent
12
11
10
9
8
7
6
5
4
3
2
1
0
9.5
10.5
11.5
12.5
13.5
Time (24 hr)

Run #8, CO (7% Oxygen)



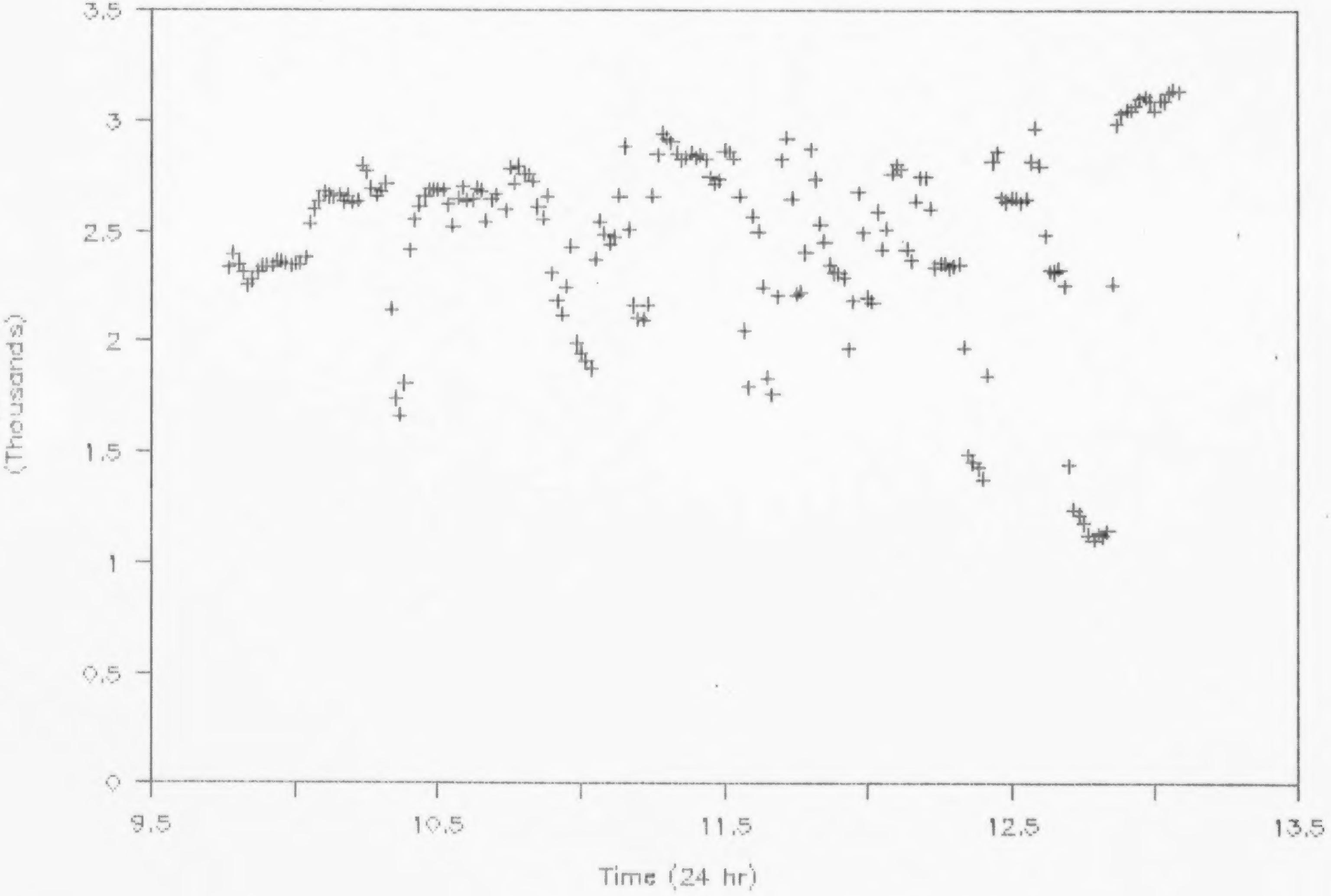


Run #8, CO (7% Oxygen), 1 min avg.

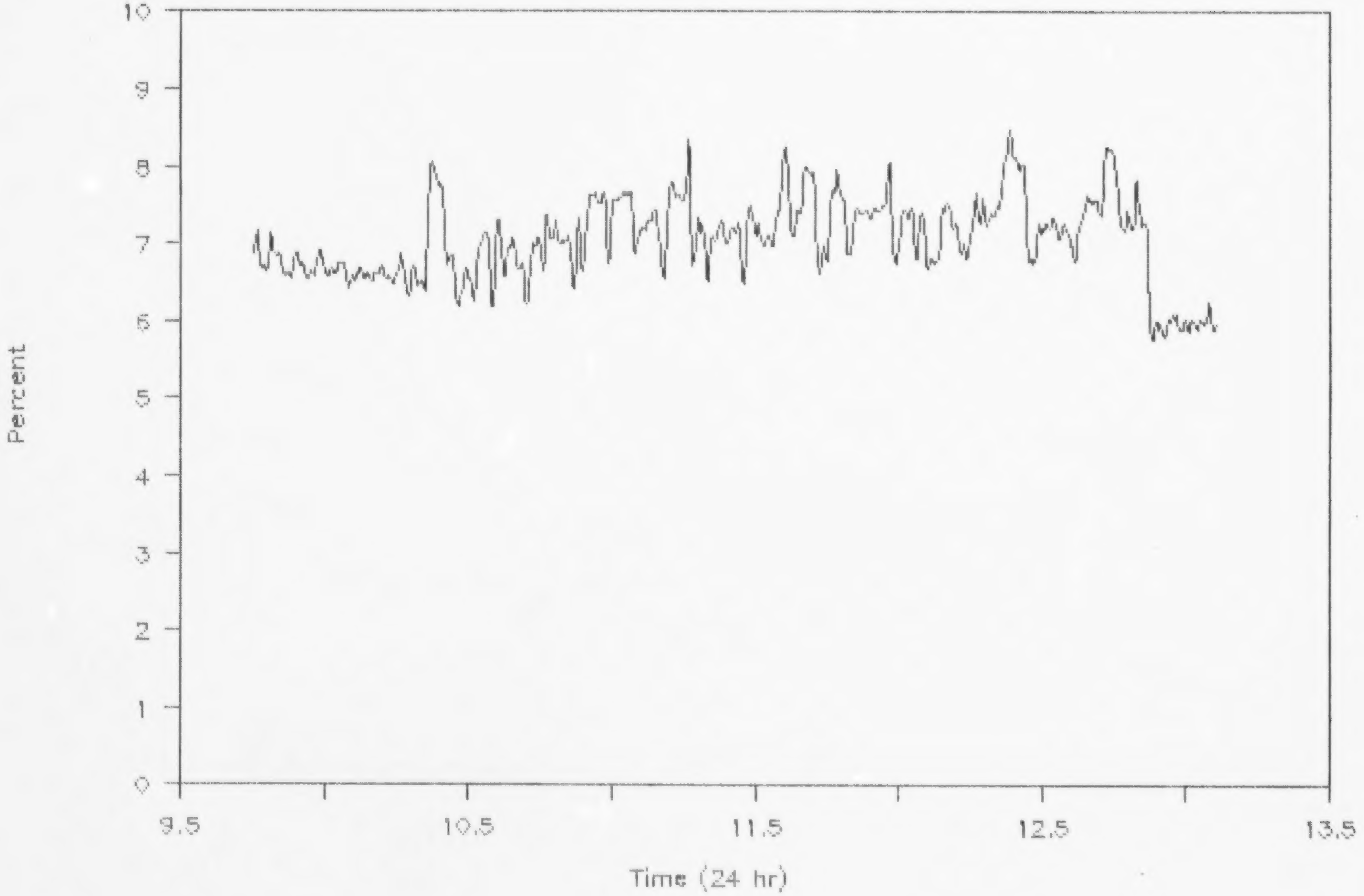


Run #8, CO (7% Oxygen), 1 hr roll avg.

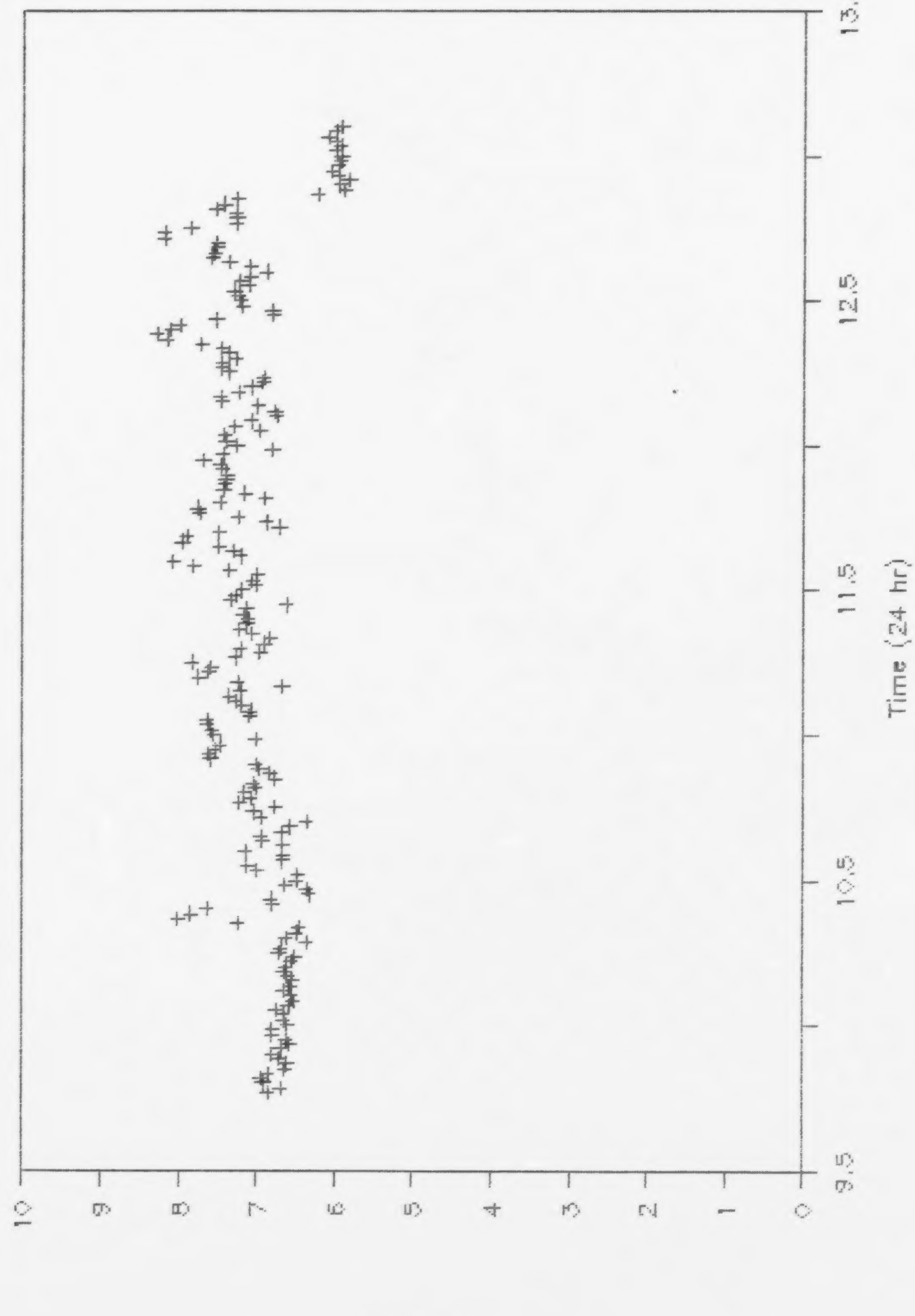
Run #8, CO, 1 min avg.



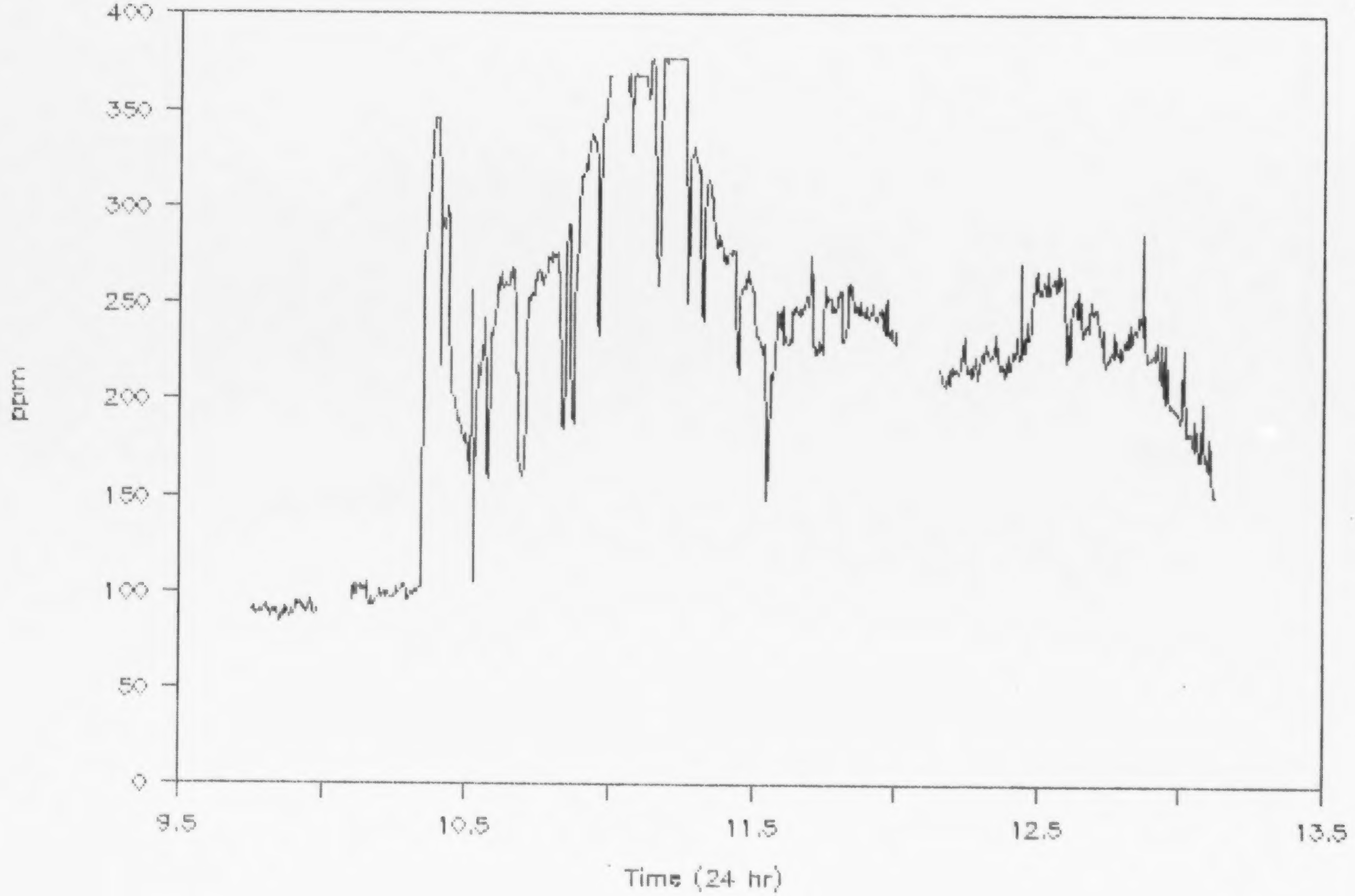
Run #8, Oxygen



Run #8, Oxygen, 1 min avg.

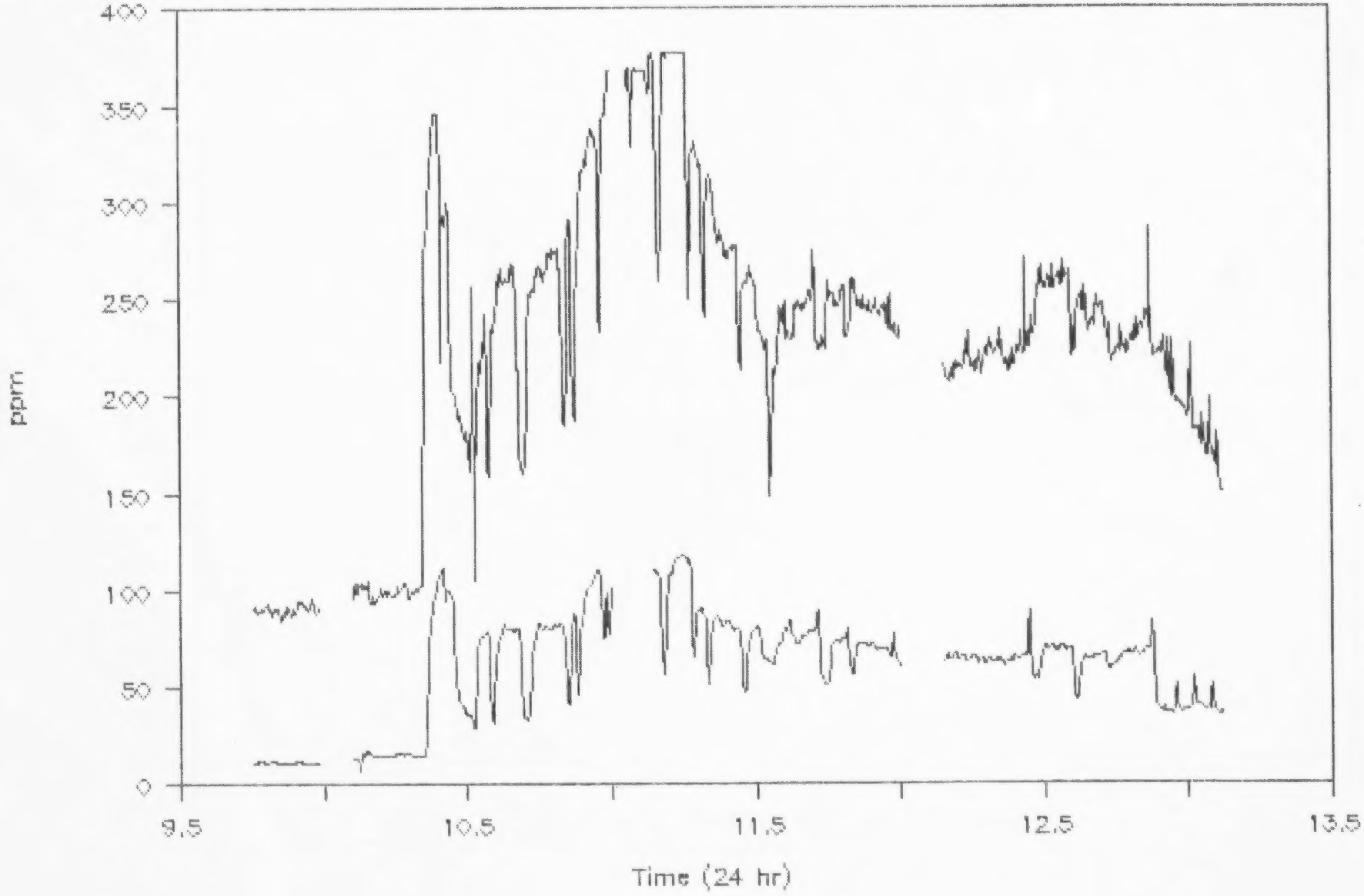


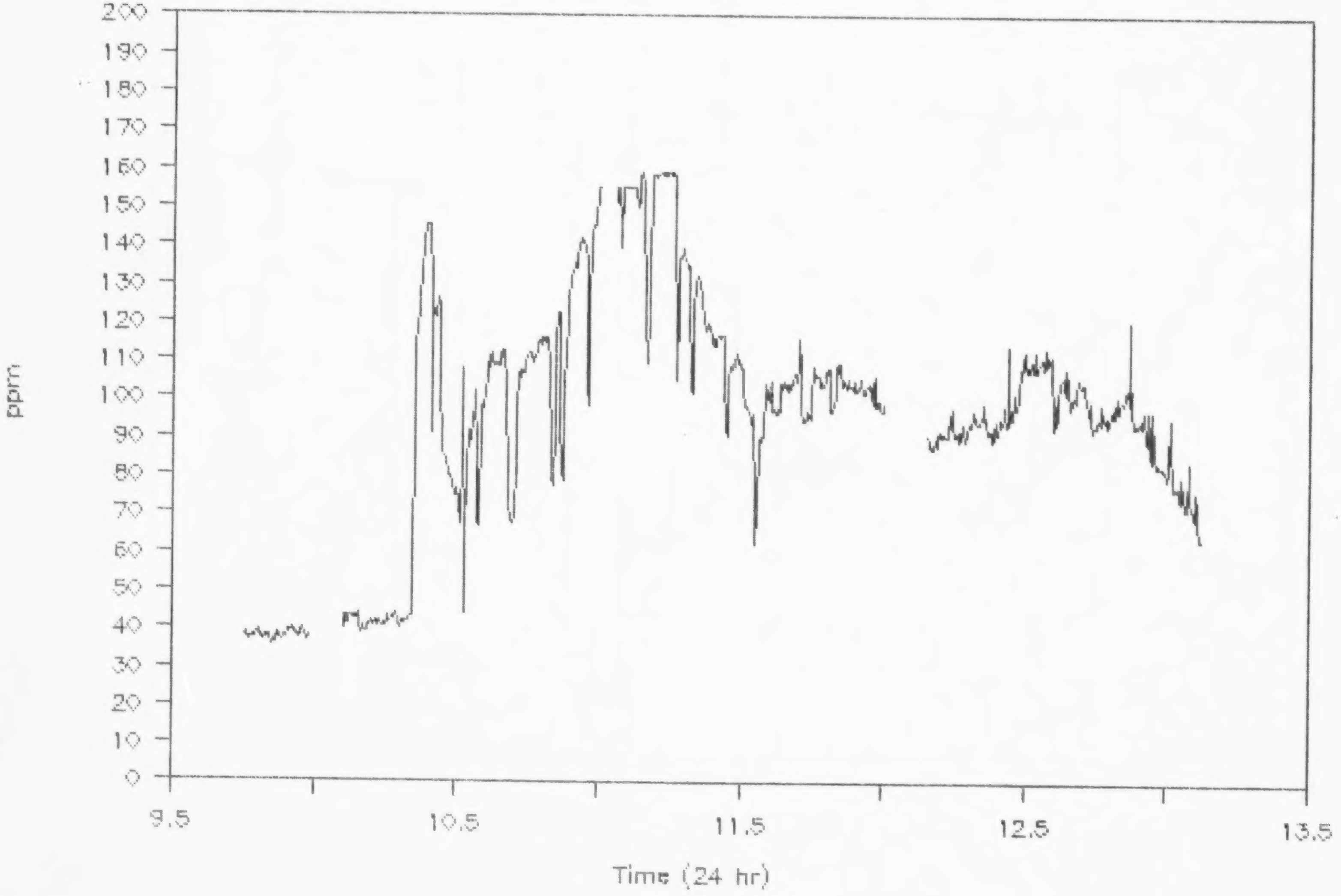
Run #8, THC (Heated, dry)



Run #8, THC (Heated, dry)

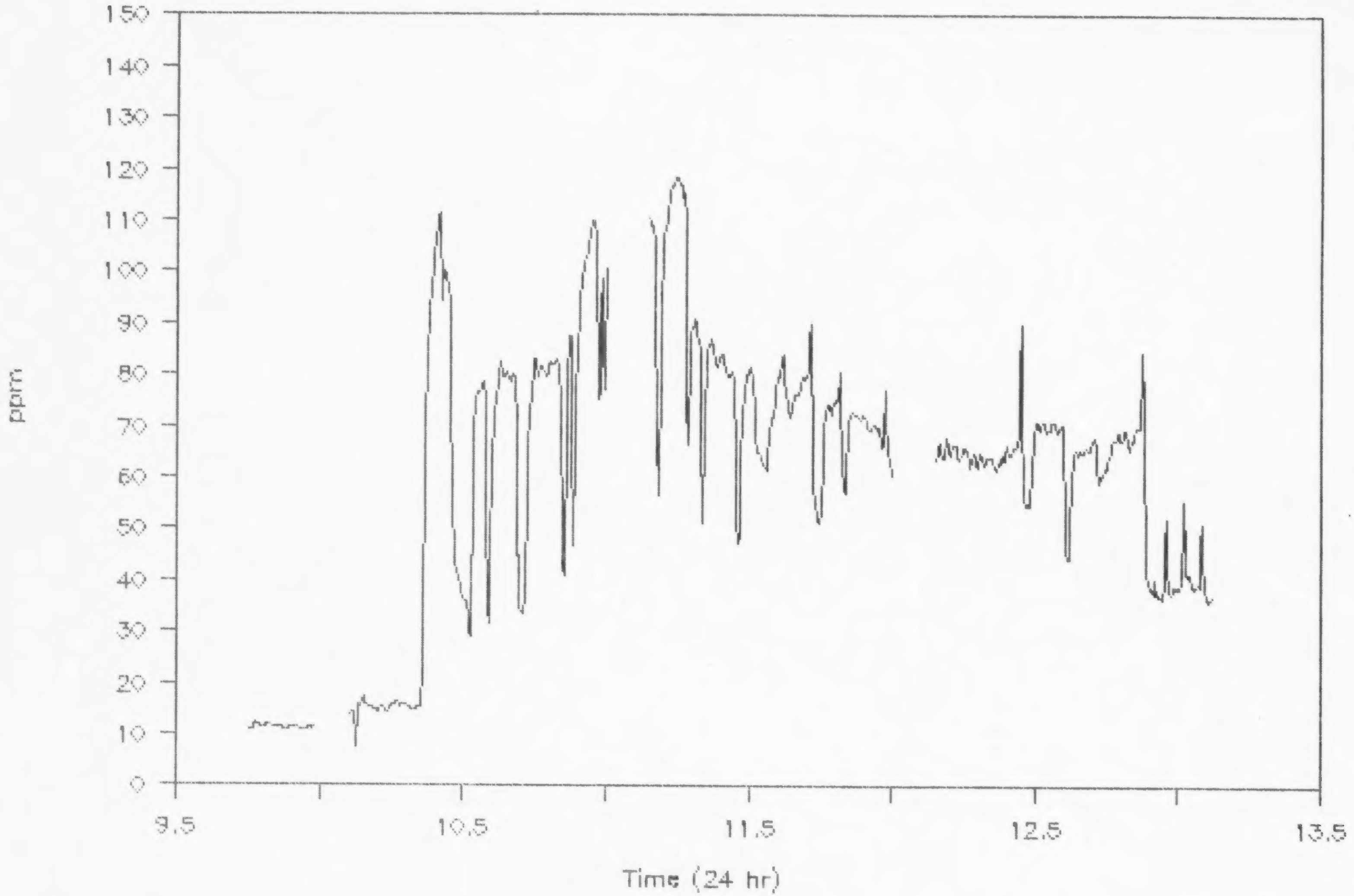
THC (Unheated)



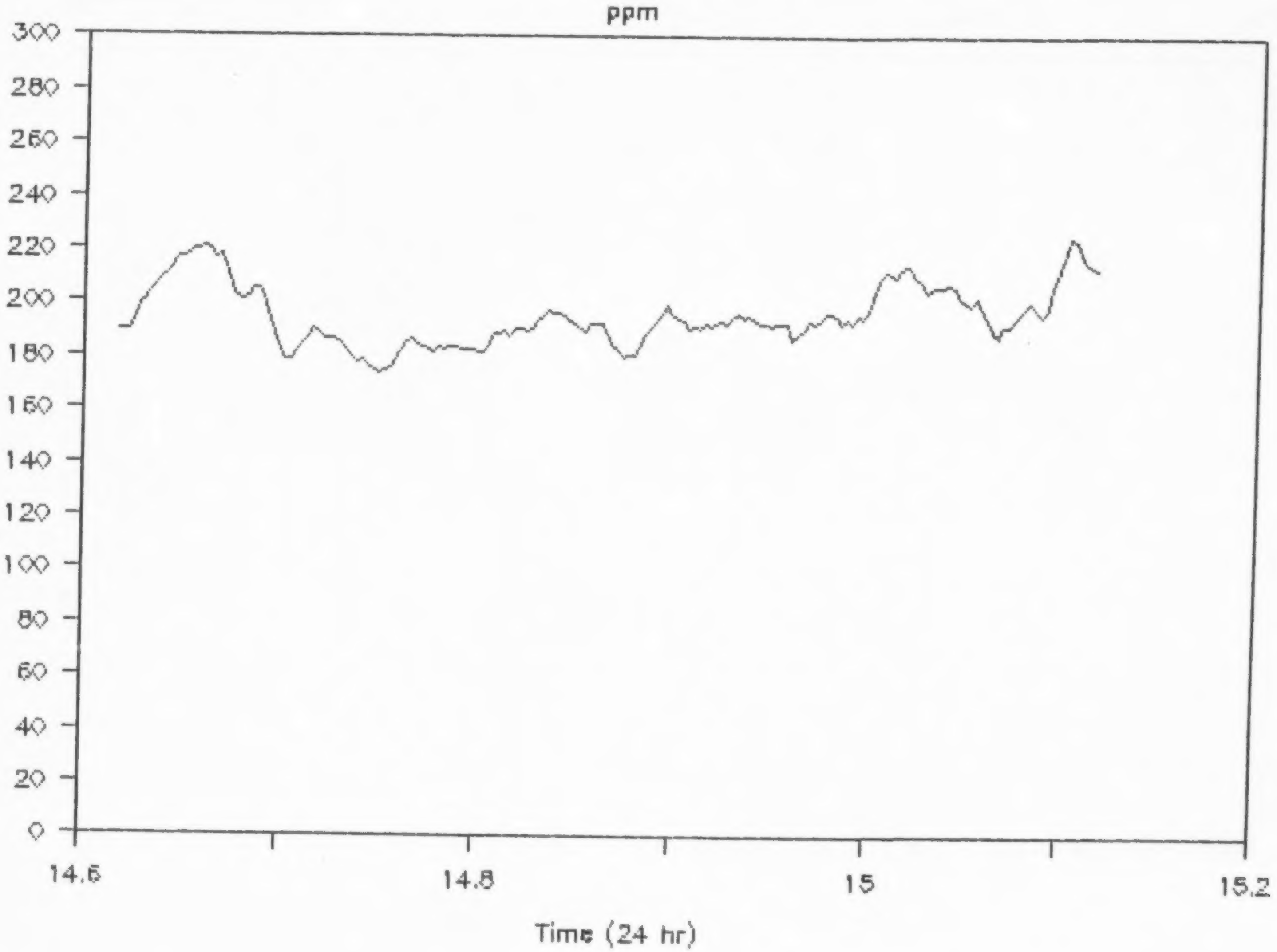


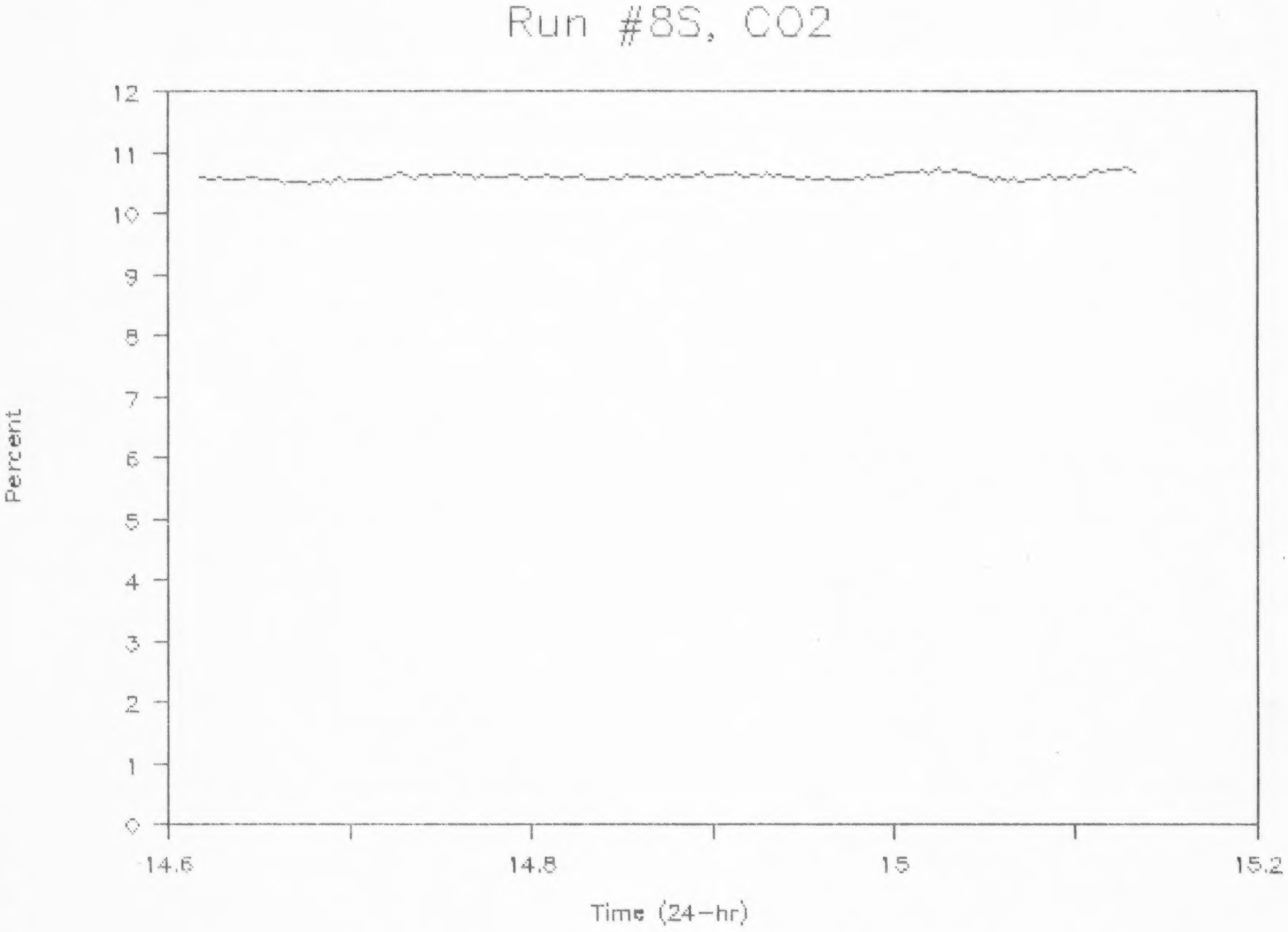
Run #8, THC (Heated, wet)

Run #8, THC (Unheated)

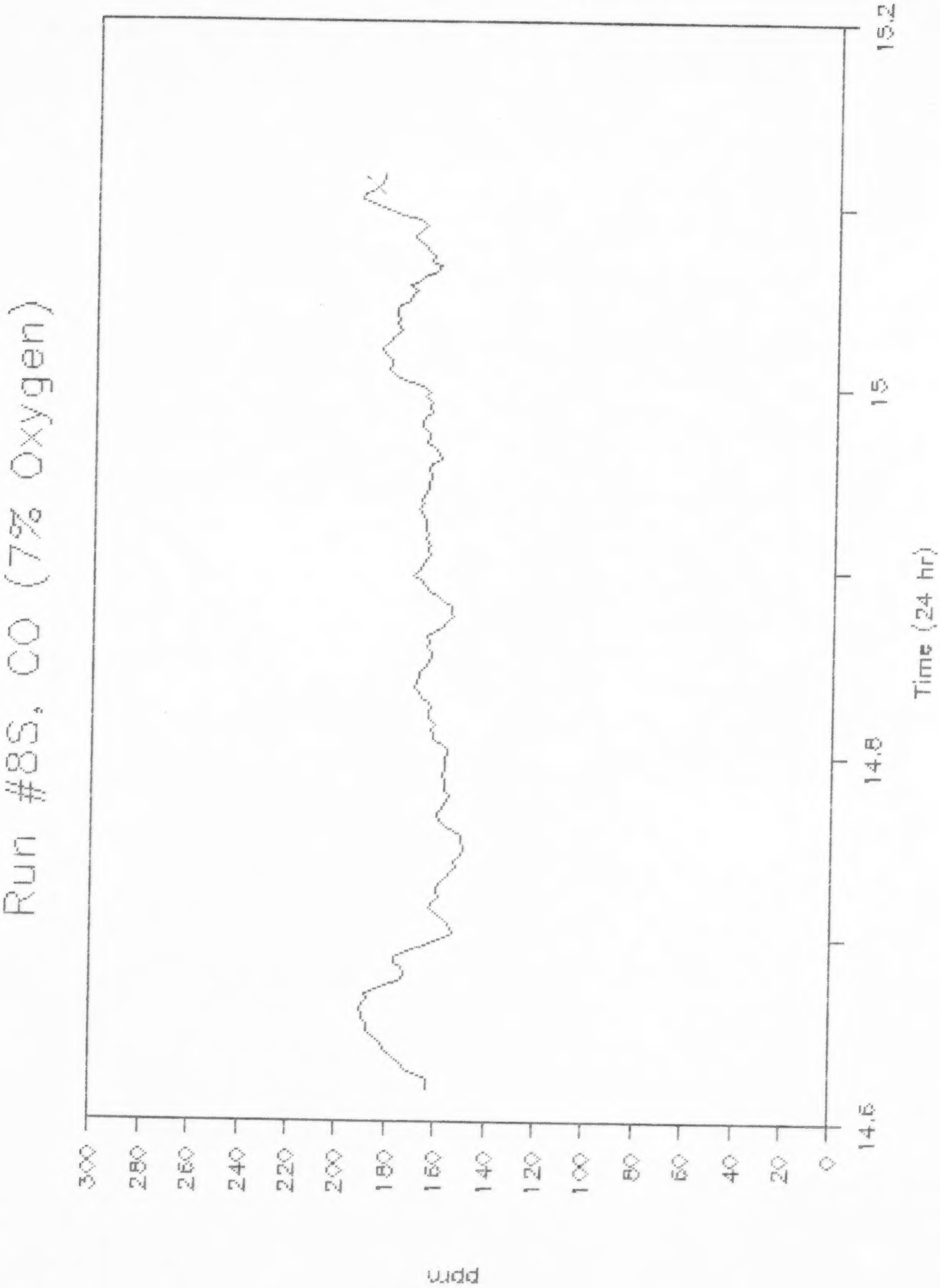


Run #8S, CO

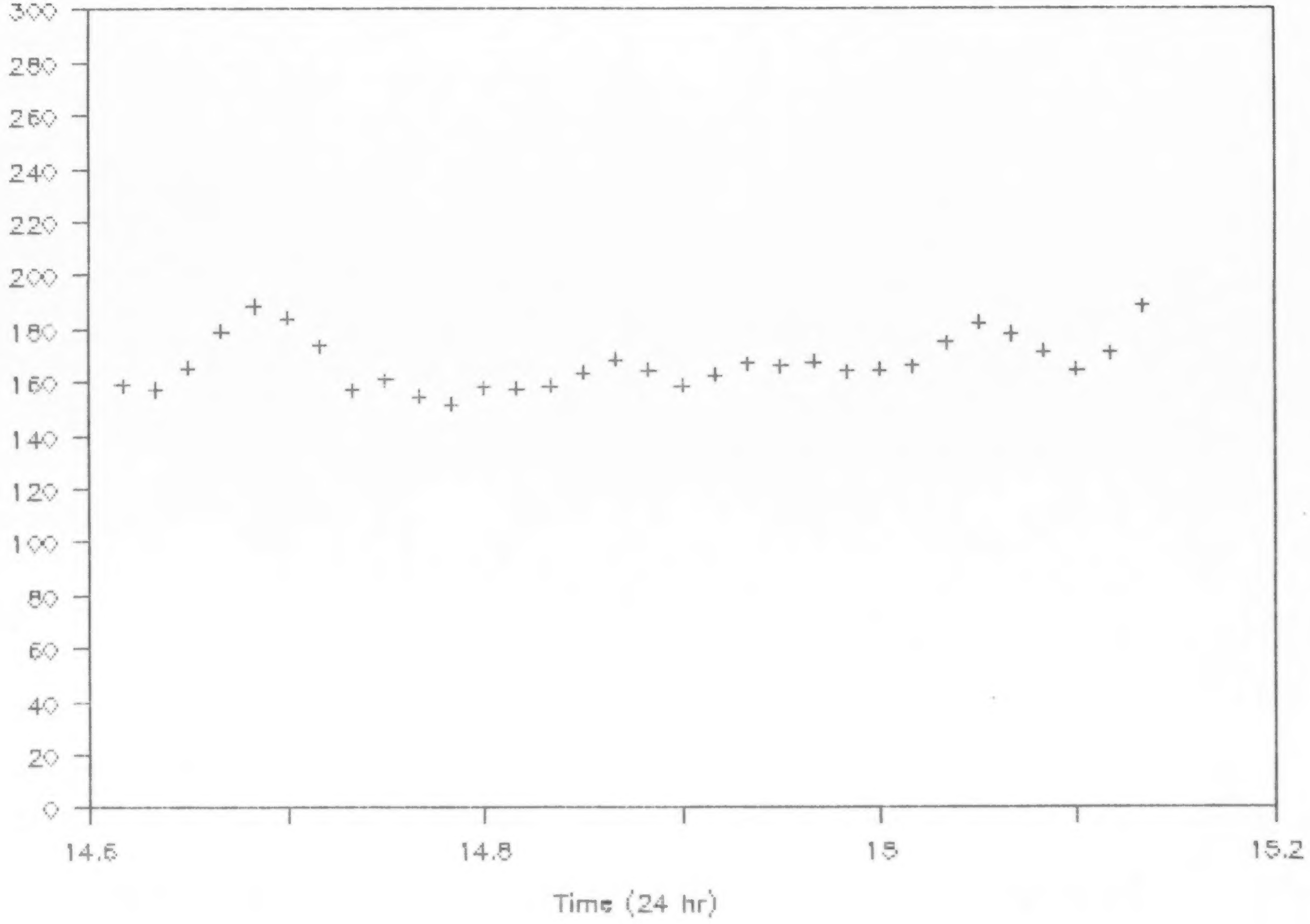

ppm
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
14.6
14.8
15
15.2
Time (24 hr)



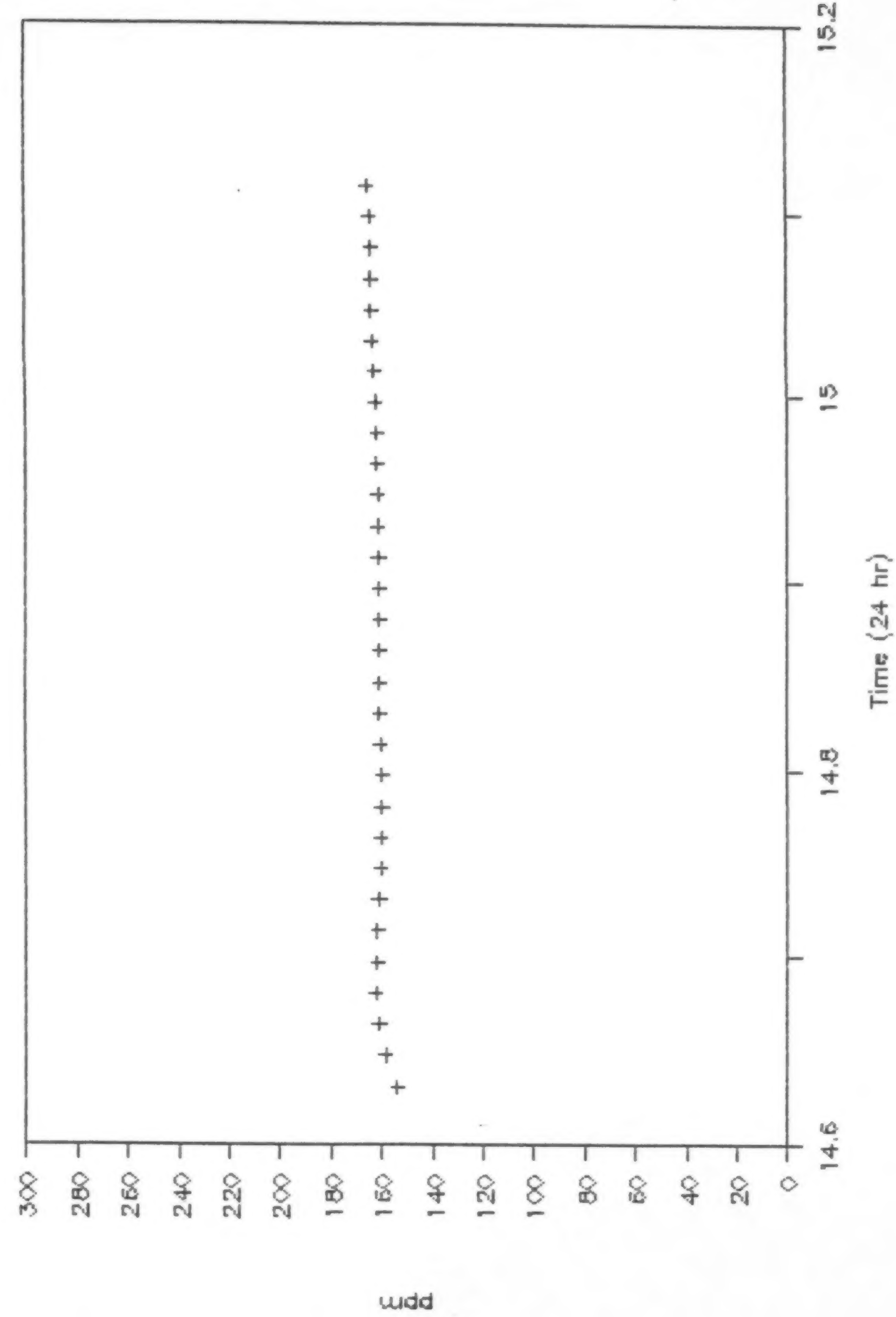
Run #8S, CO2


Run #8S, CO (7% Oxygen)
ppm
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0
Time (24 hr)
14.6
14.8
15
15.2

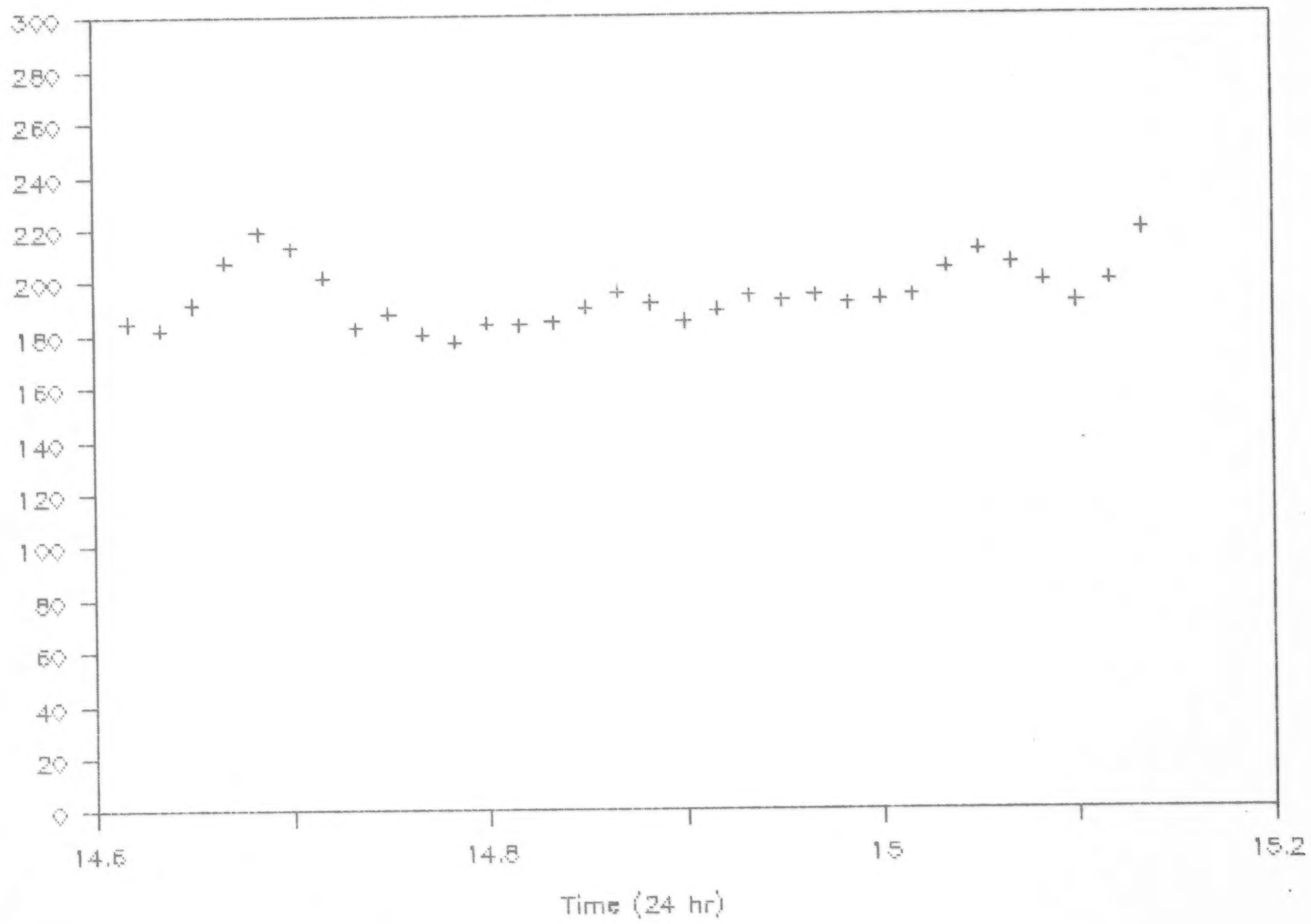
Run #8S, CO (7% Oxygen), 1 min avg.

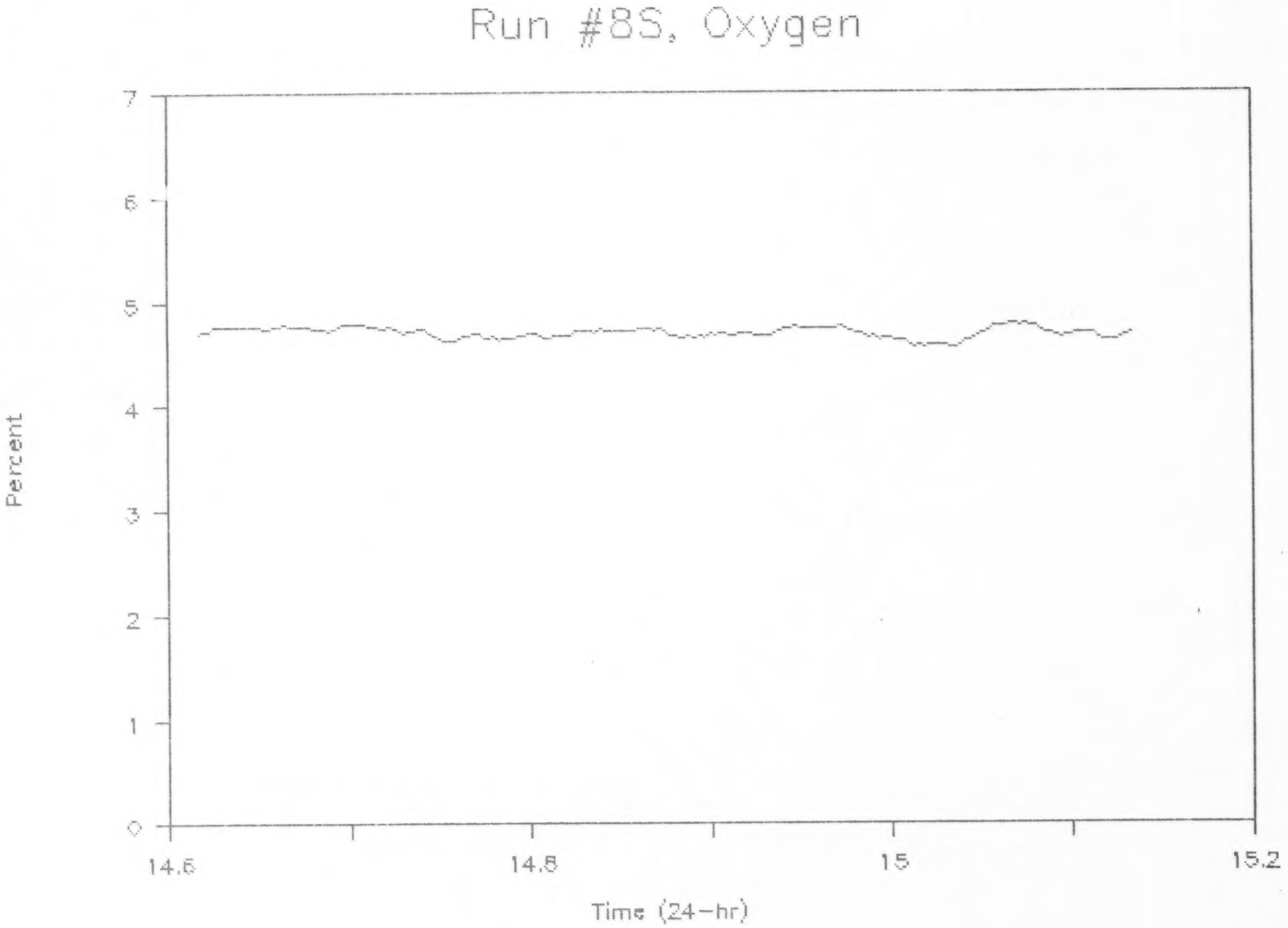


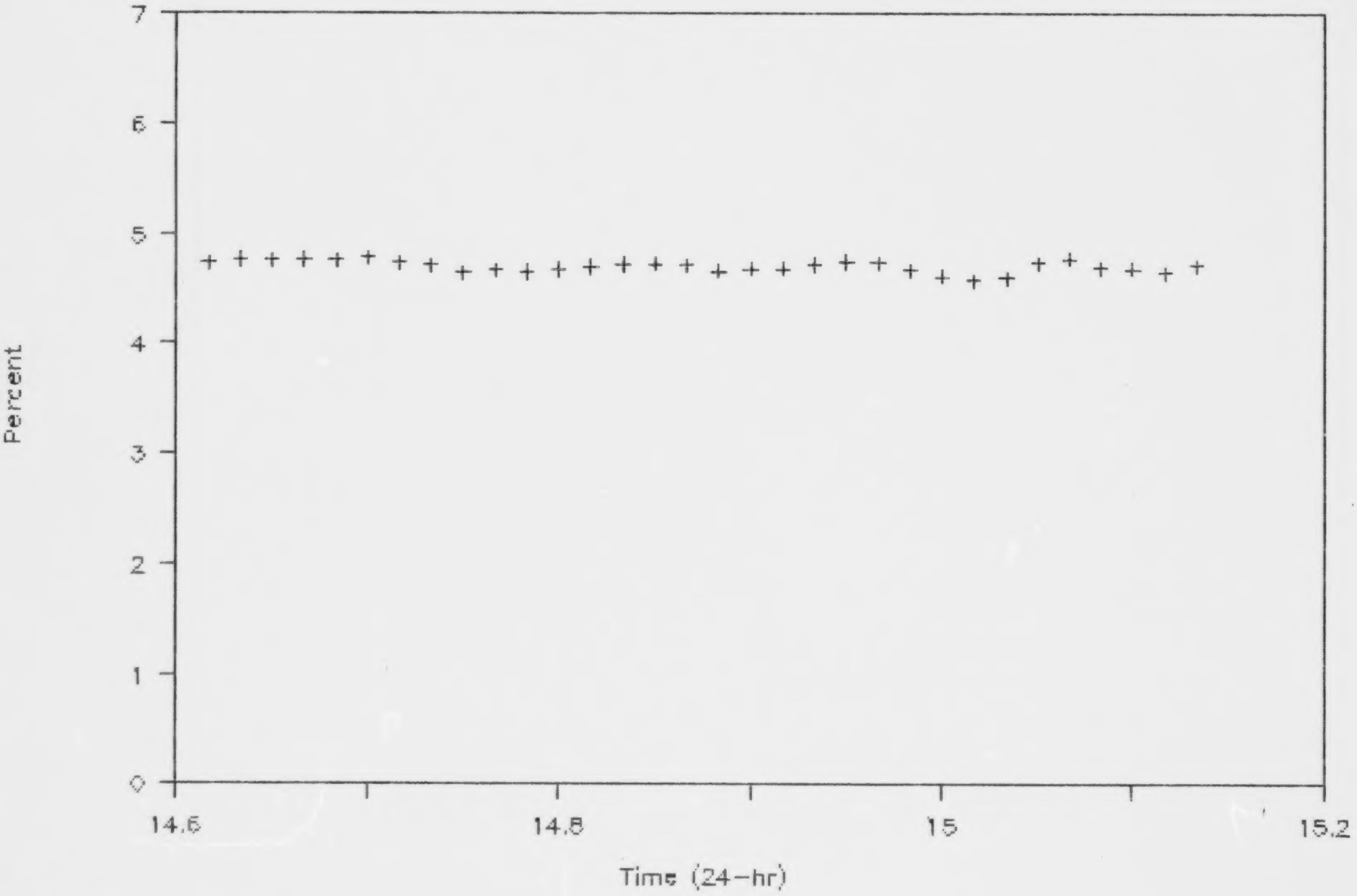
Run #8S, CO (7% Oxygen), 1 hr roll avg.



Run #8S, CO, 1 min avg.

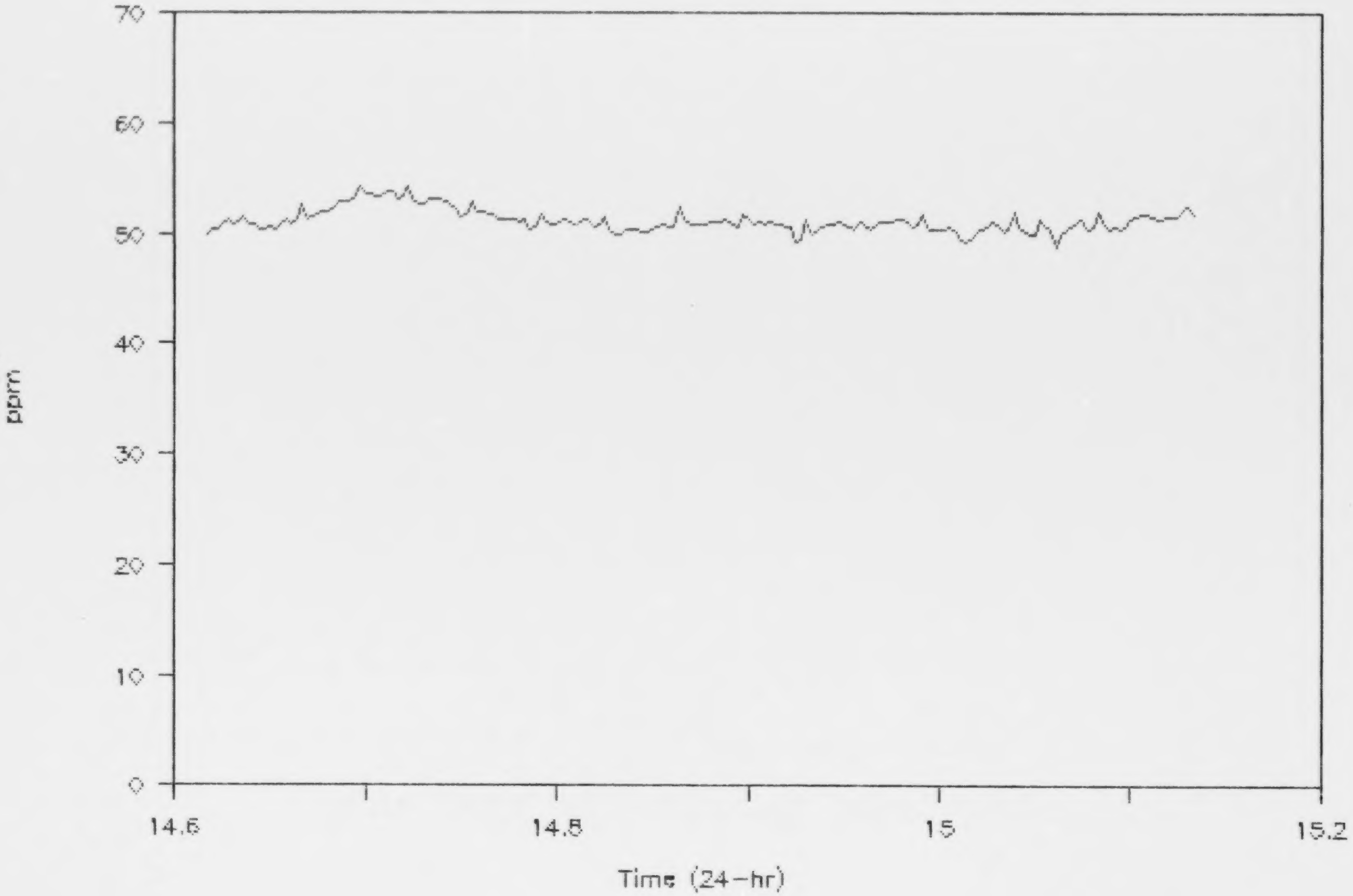


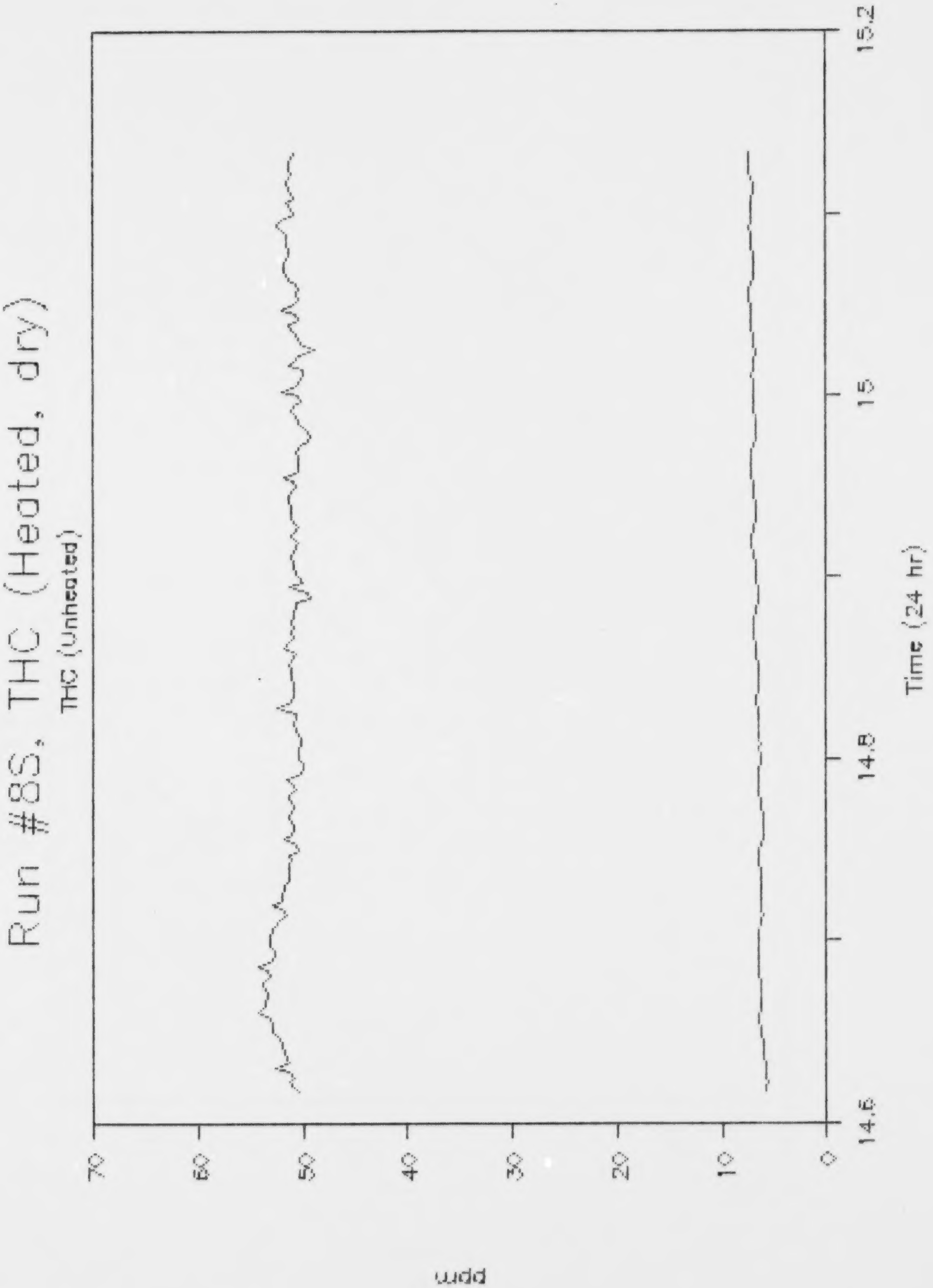

Run #8S, Oxygen



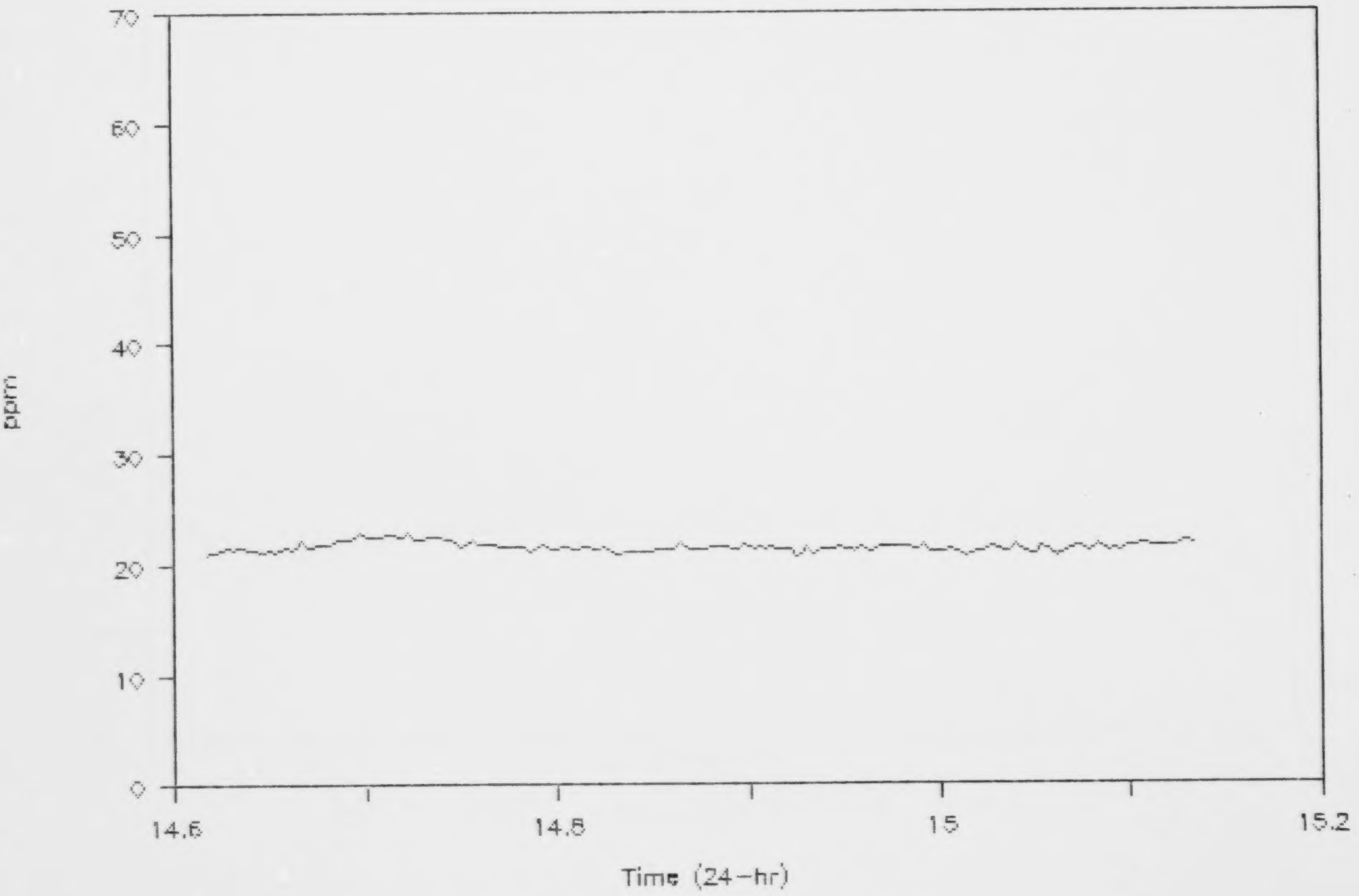
Run #8S, Oxygen, 1 min avg.

Run #8S, THC (Heated, dry)

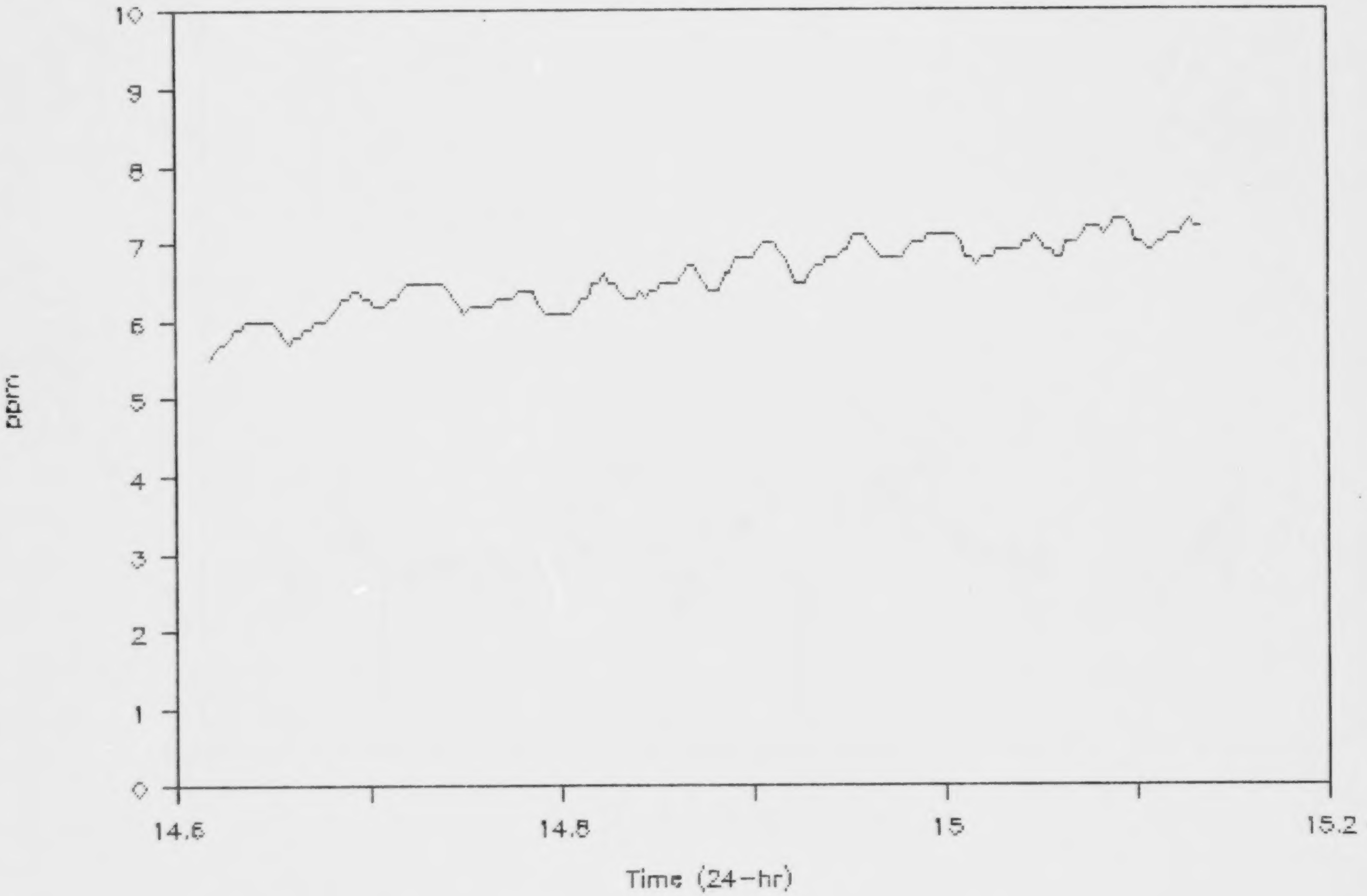


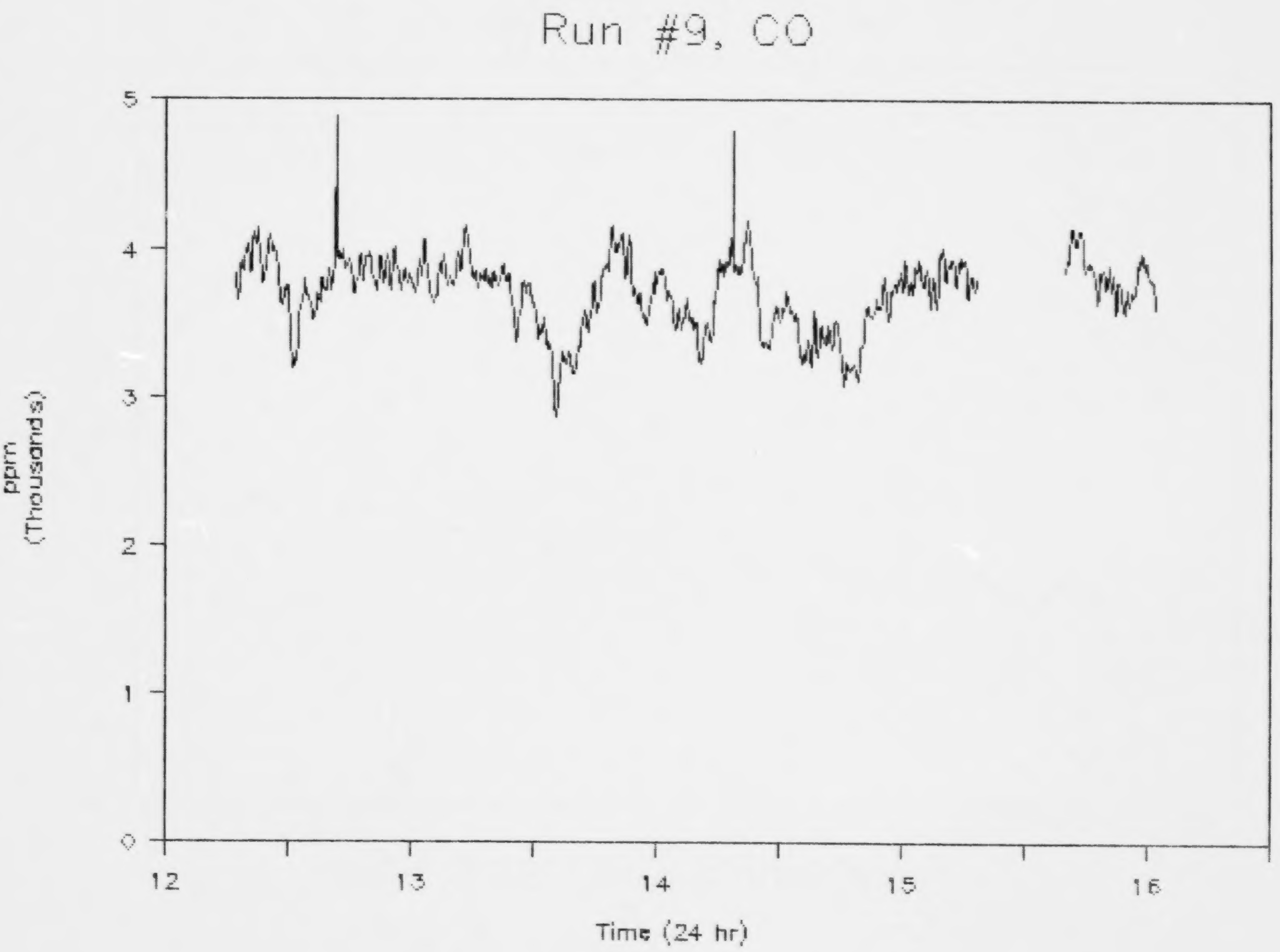

Run #8S, THC (Heated, dry)
THC (Unheated)
ppm
70
60
50
40
30
20
10
0
14.6
14.8
15
15.2
Time (24 hr)

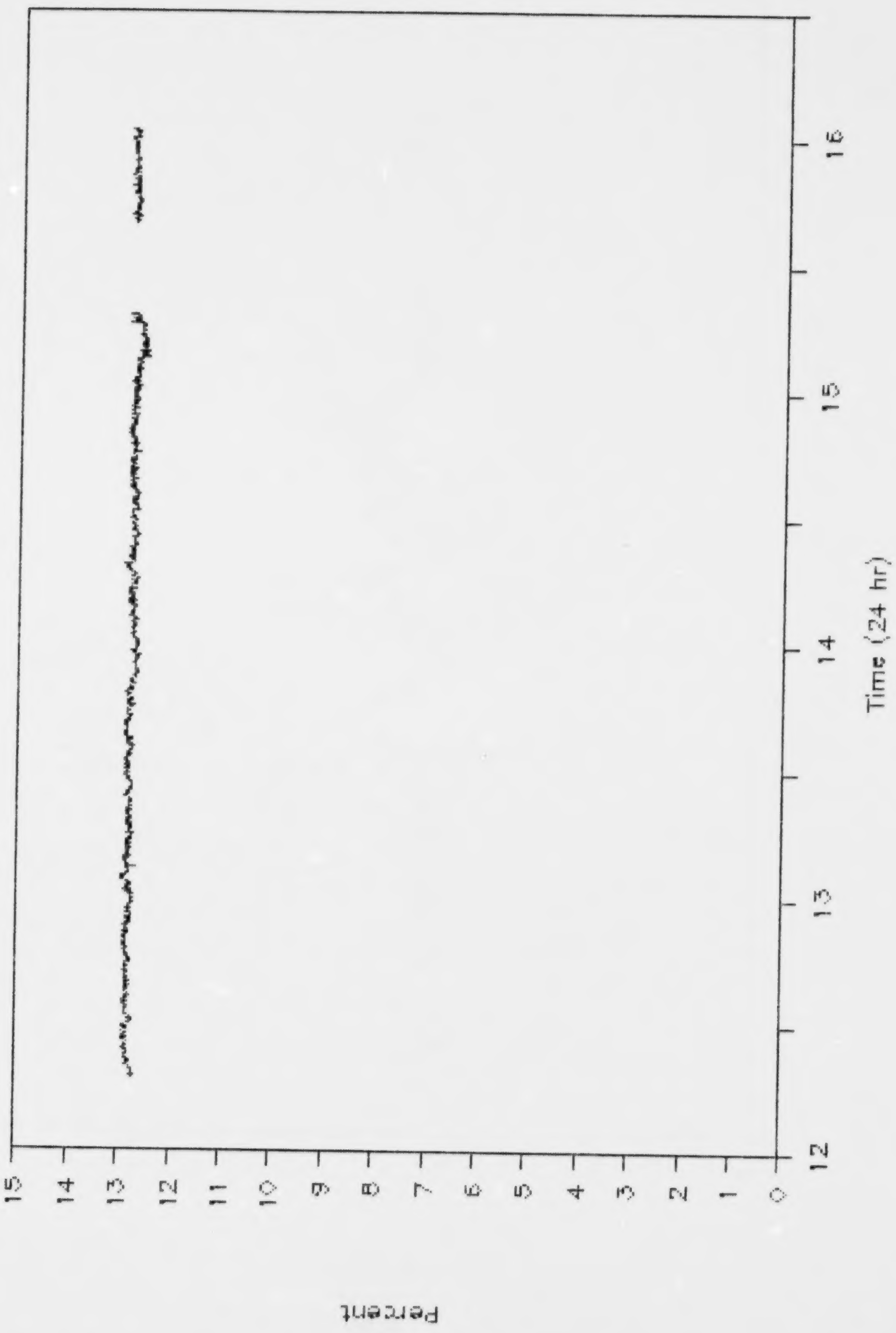
Run #8S, THC (Heated, wet)



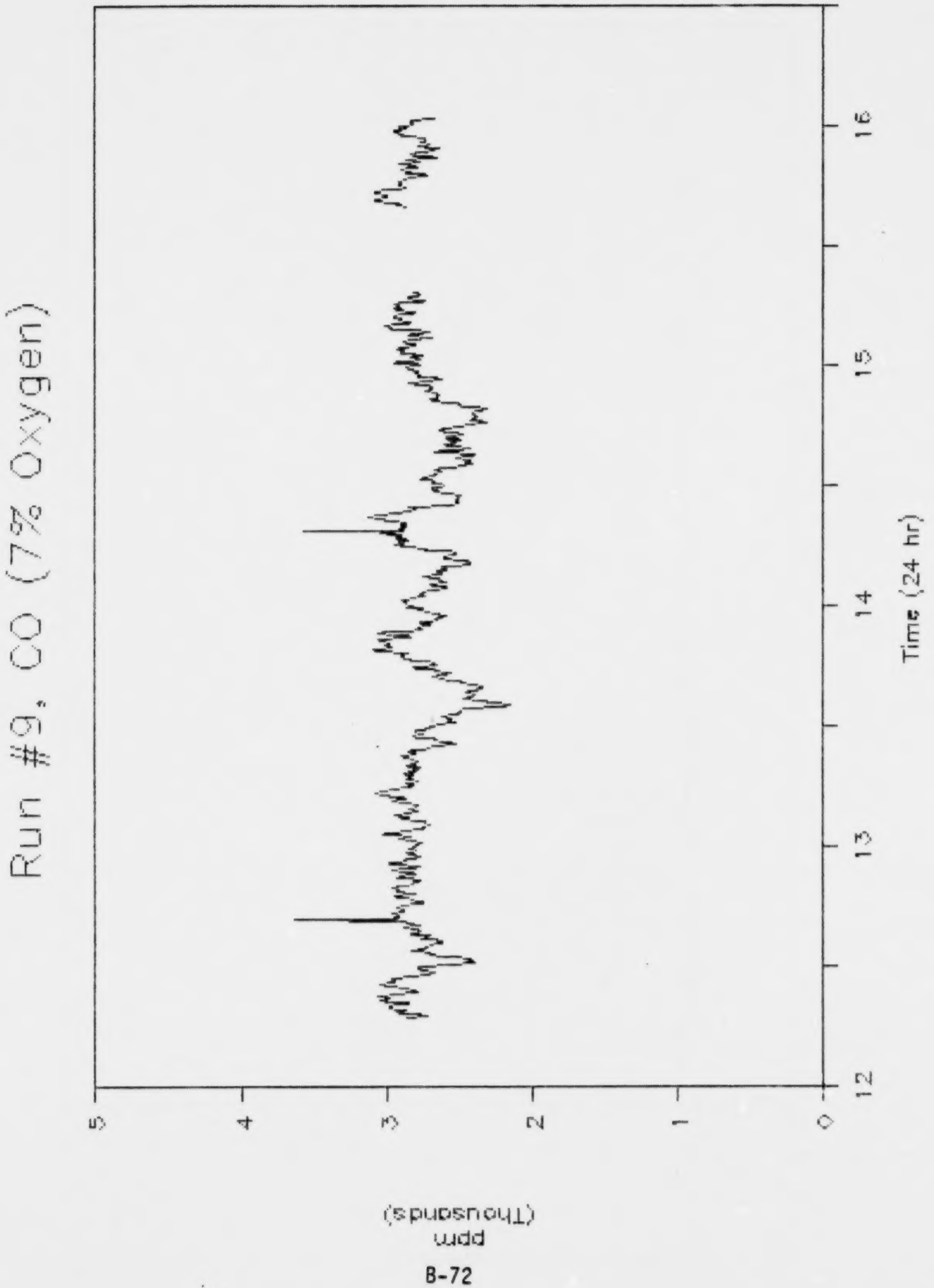
Run #8S, THC (Unheated)

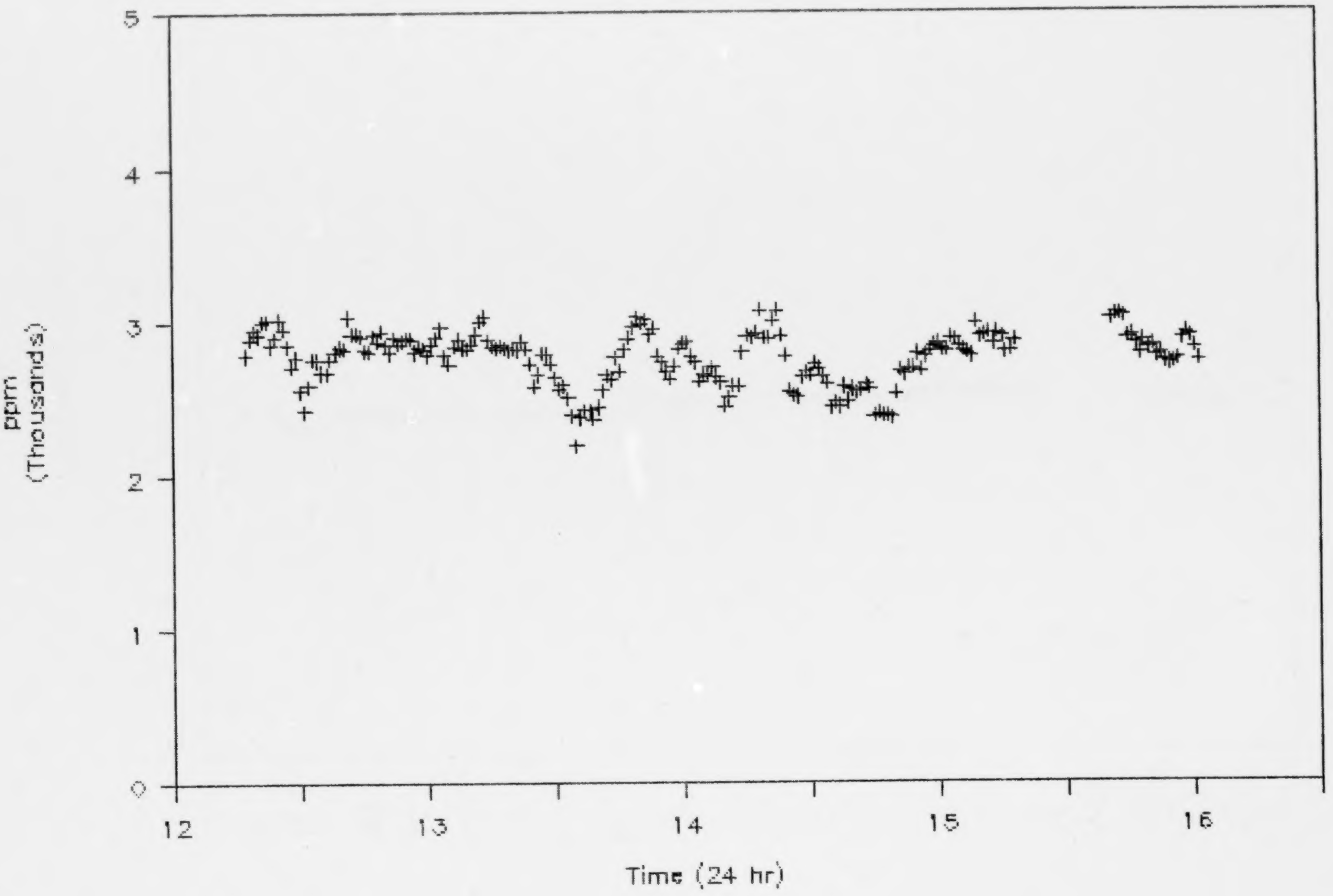



Run #9, CO
ppm
(Thousands)
0
1
2
3
4
5
12
13
14
15
16
Time (24 hr)

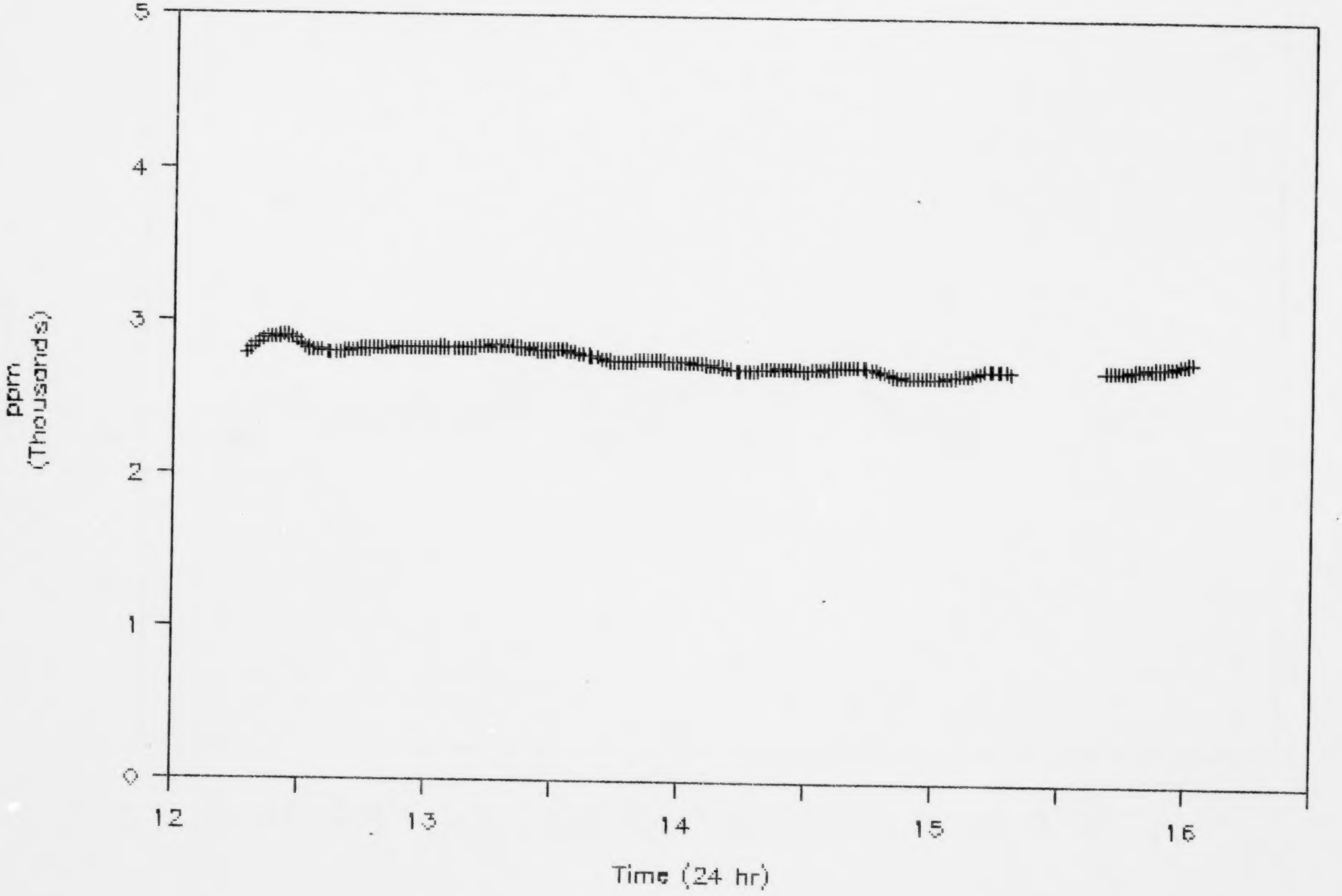


Run #9, CO2

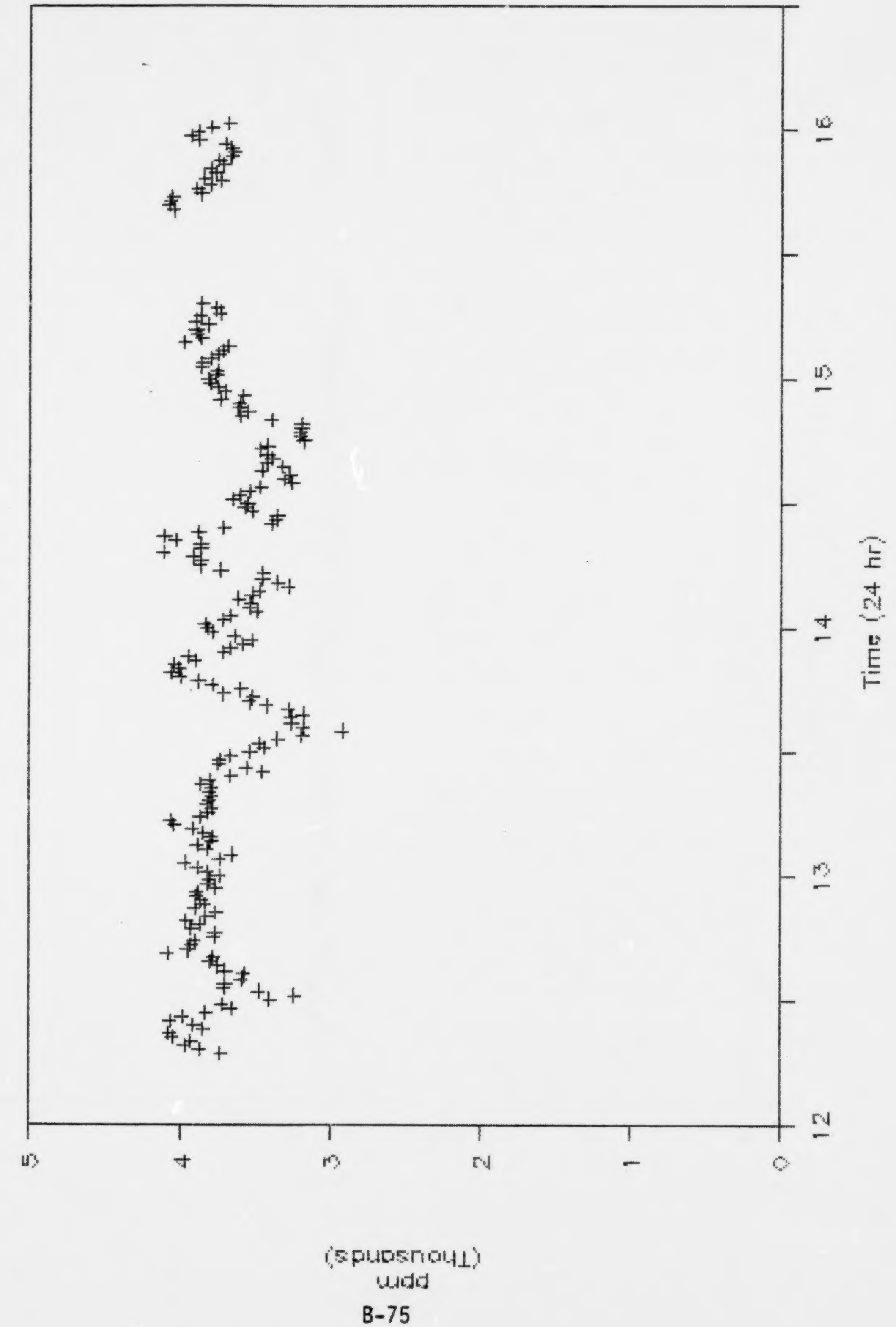

Run #9, CO (7% Oxygen)
ppm
(Thousands)
0
1
2
3
4
5
12
13
14
15
16
Time (24 hr)

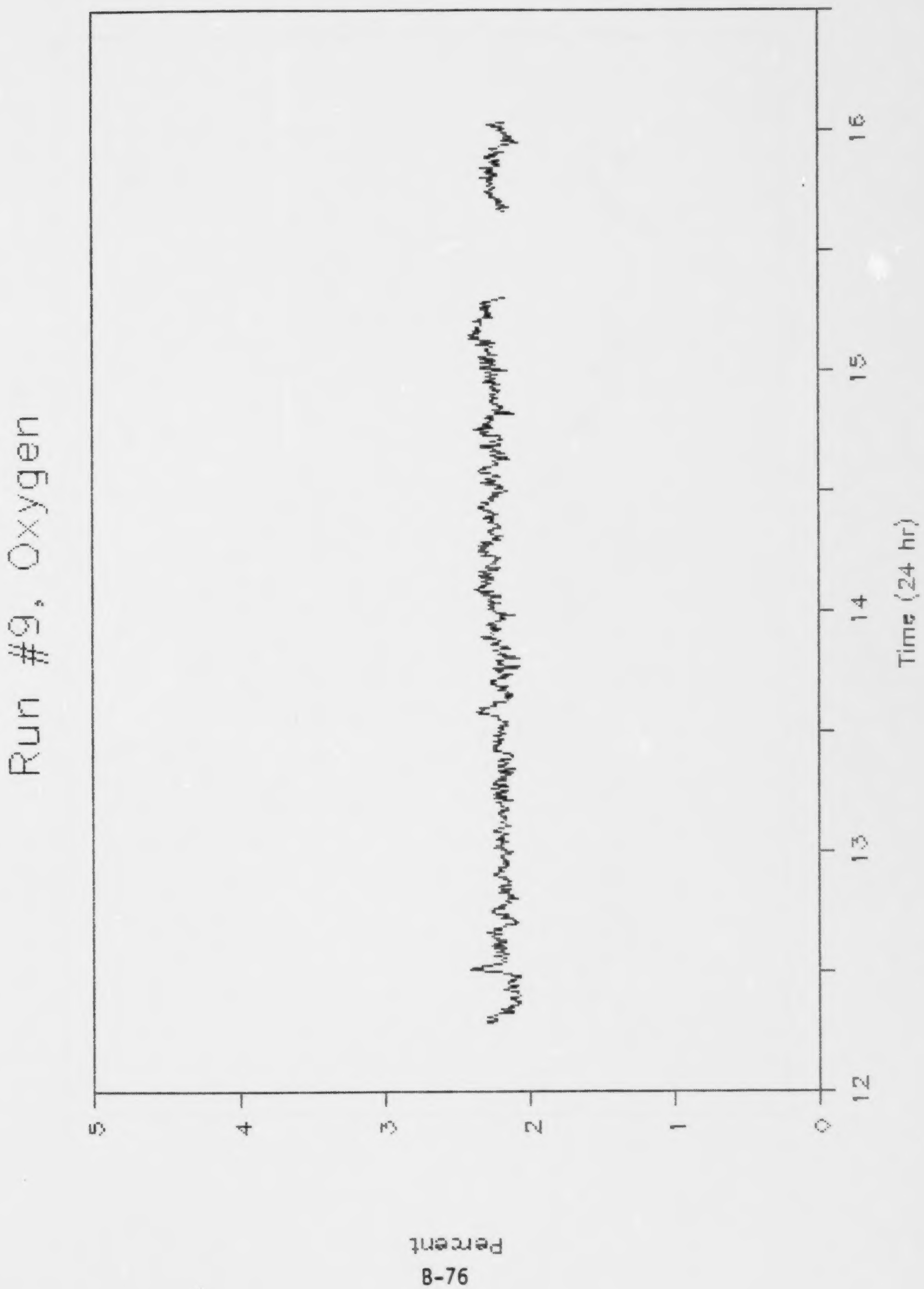

Run #9, CO (7% Oxygen), 1 min avg.

Run #9, CO (7% Oxygen), 1 hr roll avg.

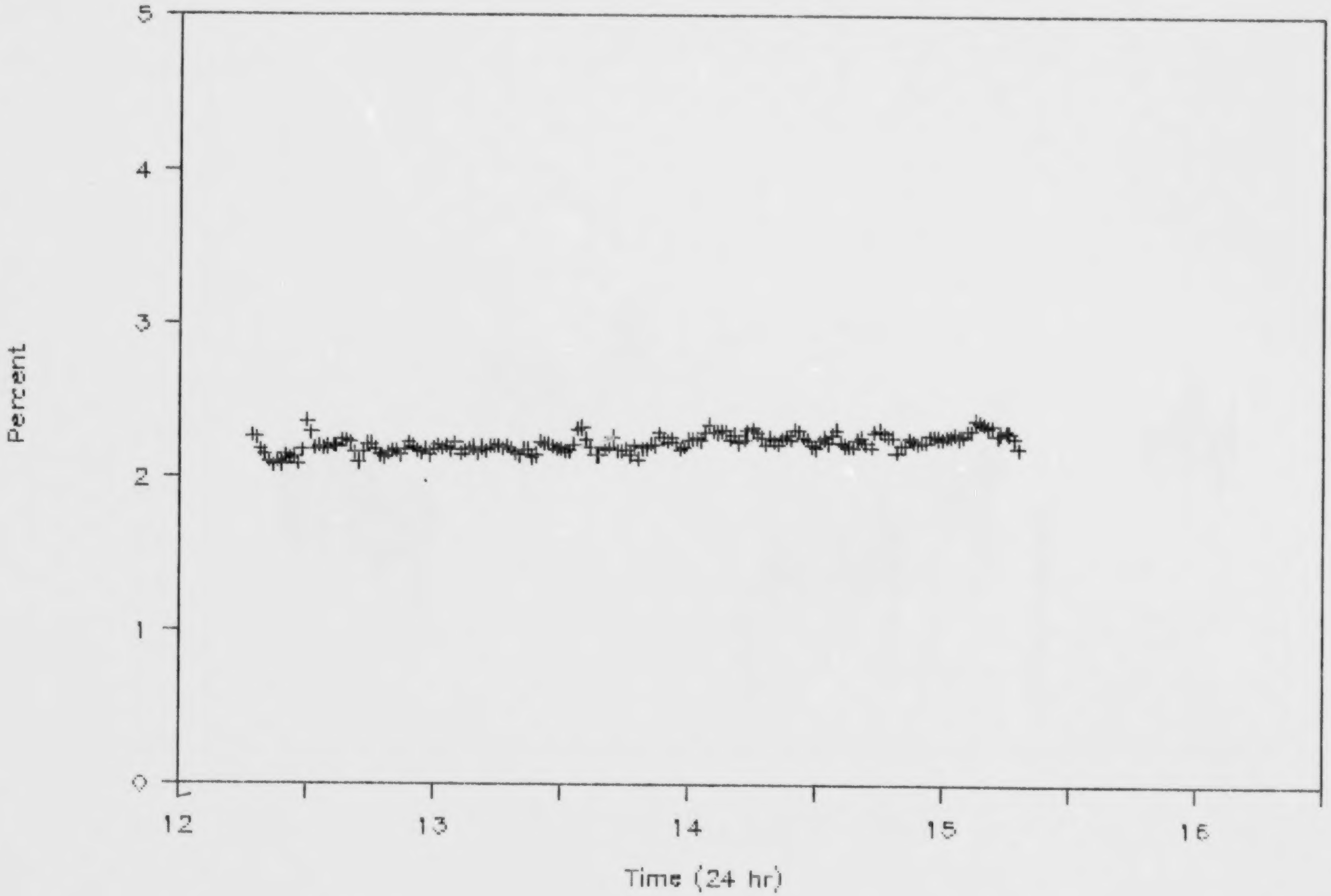


Run #9, CO, 1 min avg.

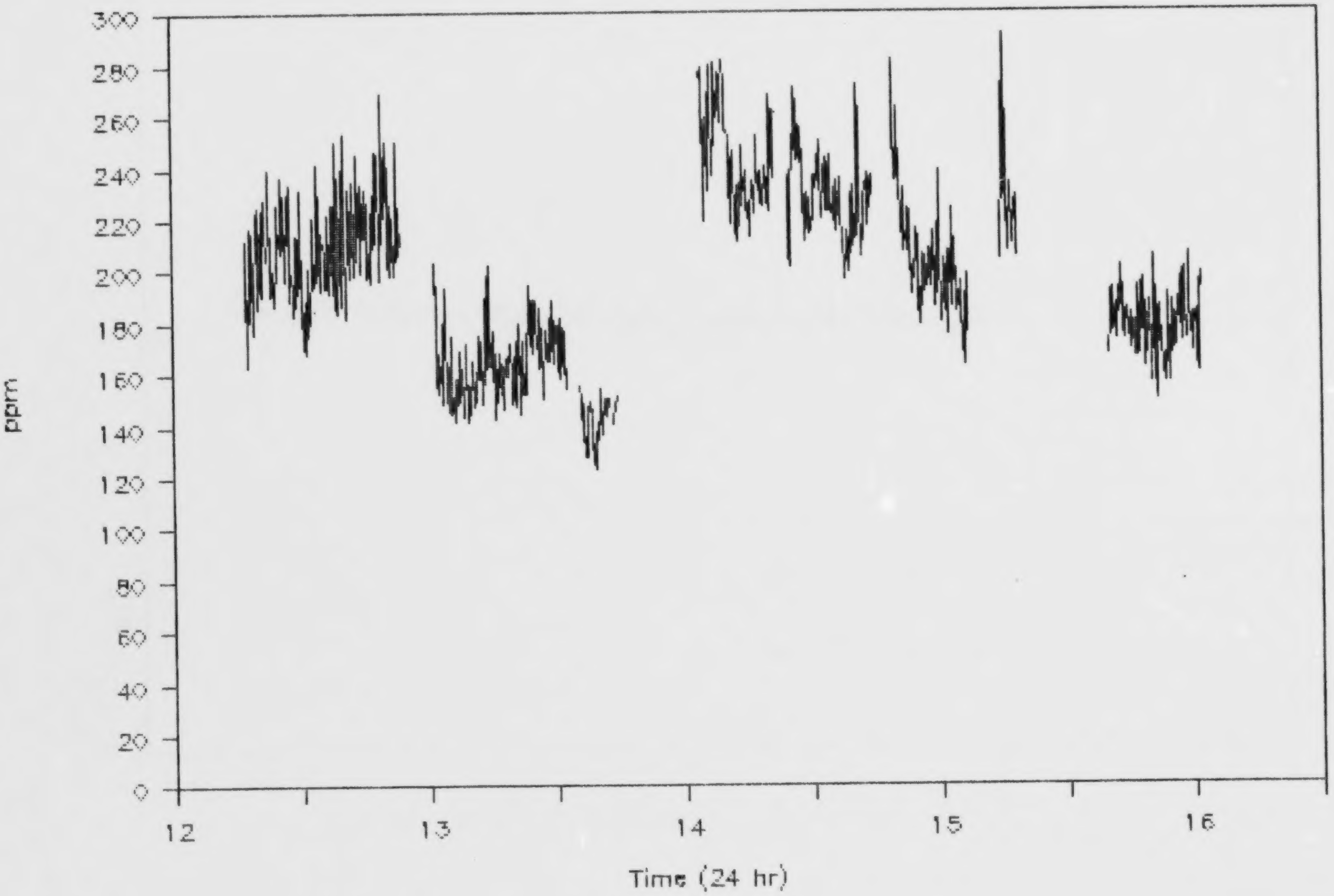


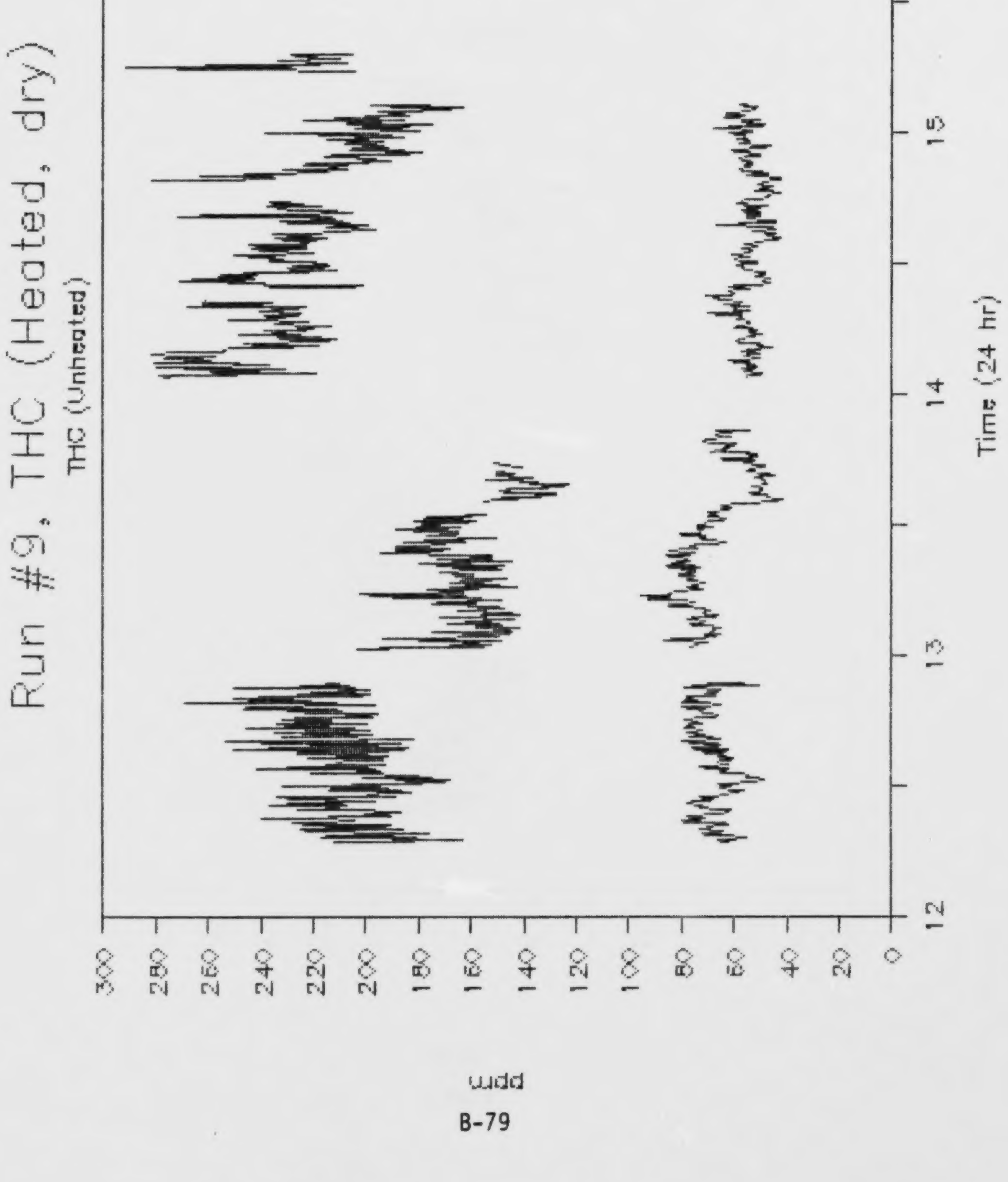

Run #9, Oxygen

Run #9, Oxygen, 1 min avg.



Run #9, THC (Heated, dry)

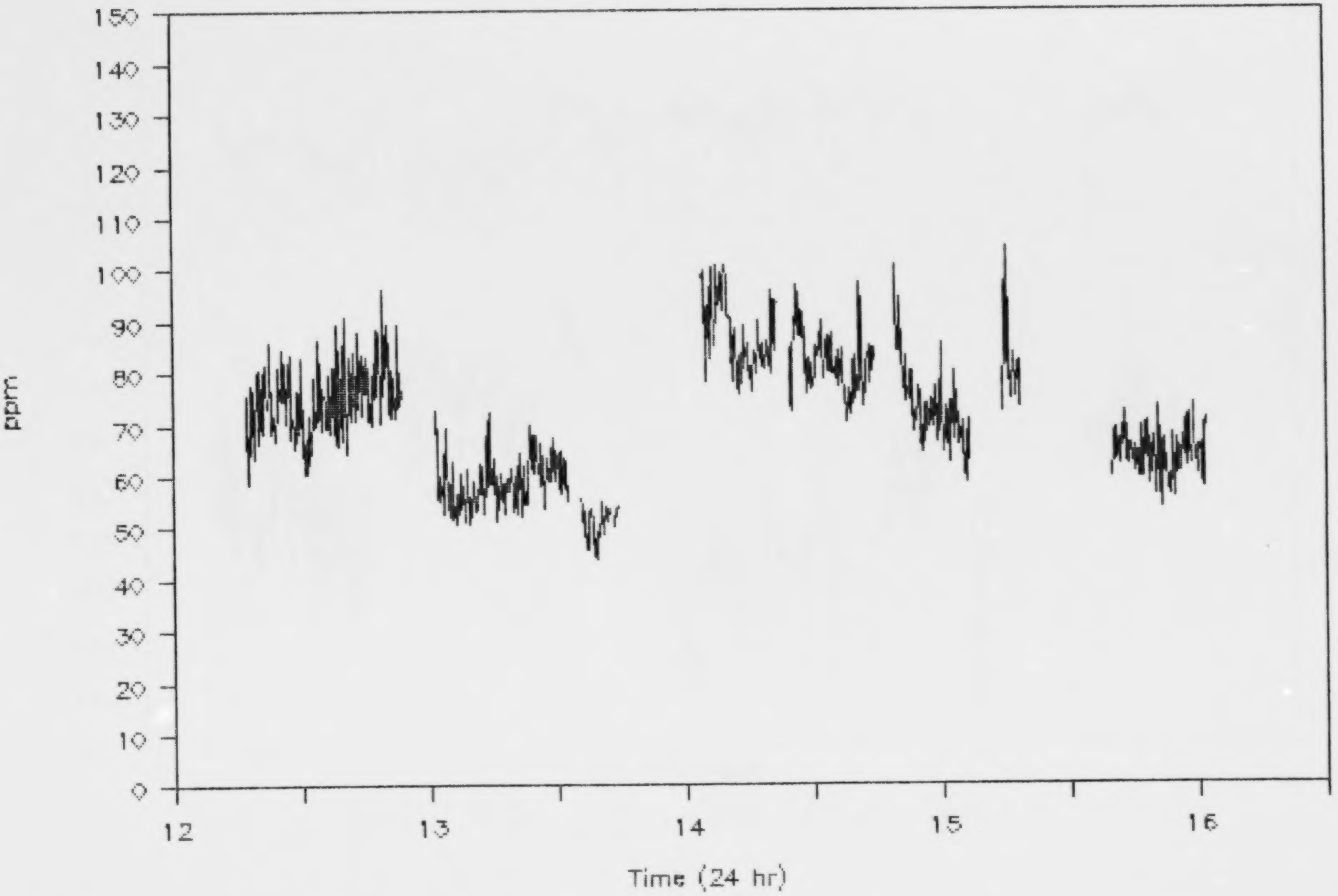




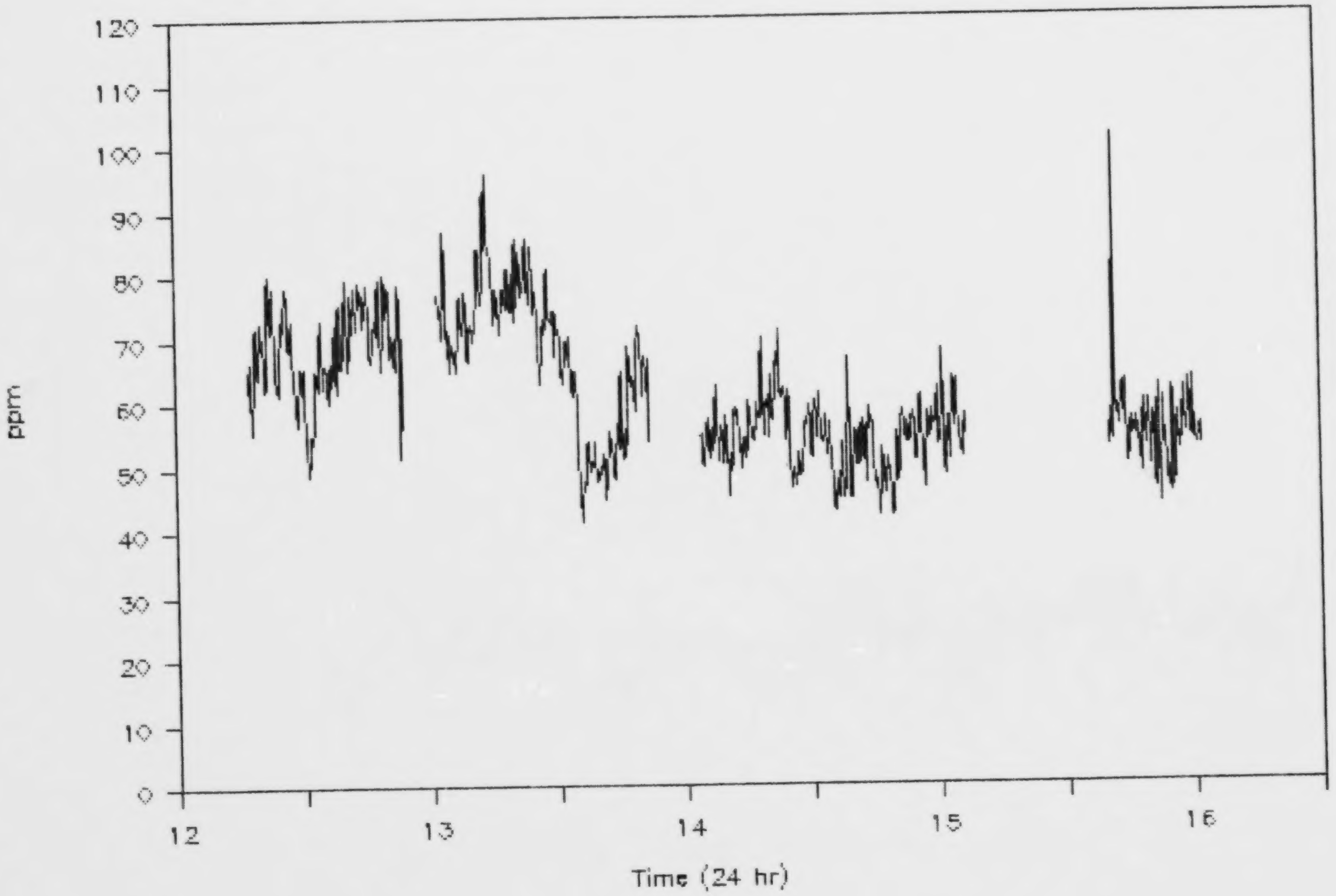
Run #9, THC (Heated, dry)

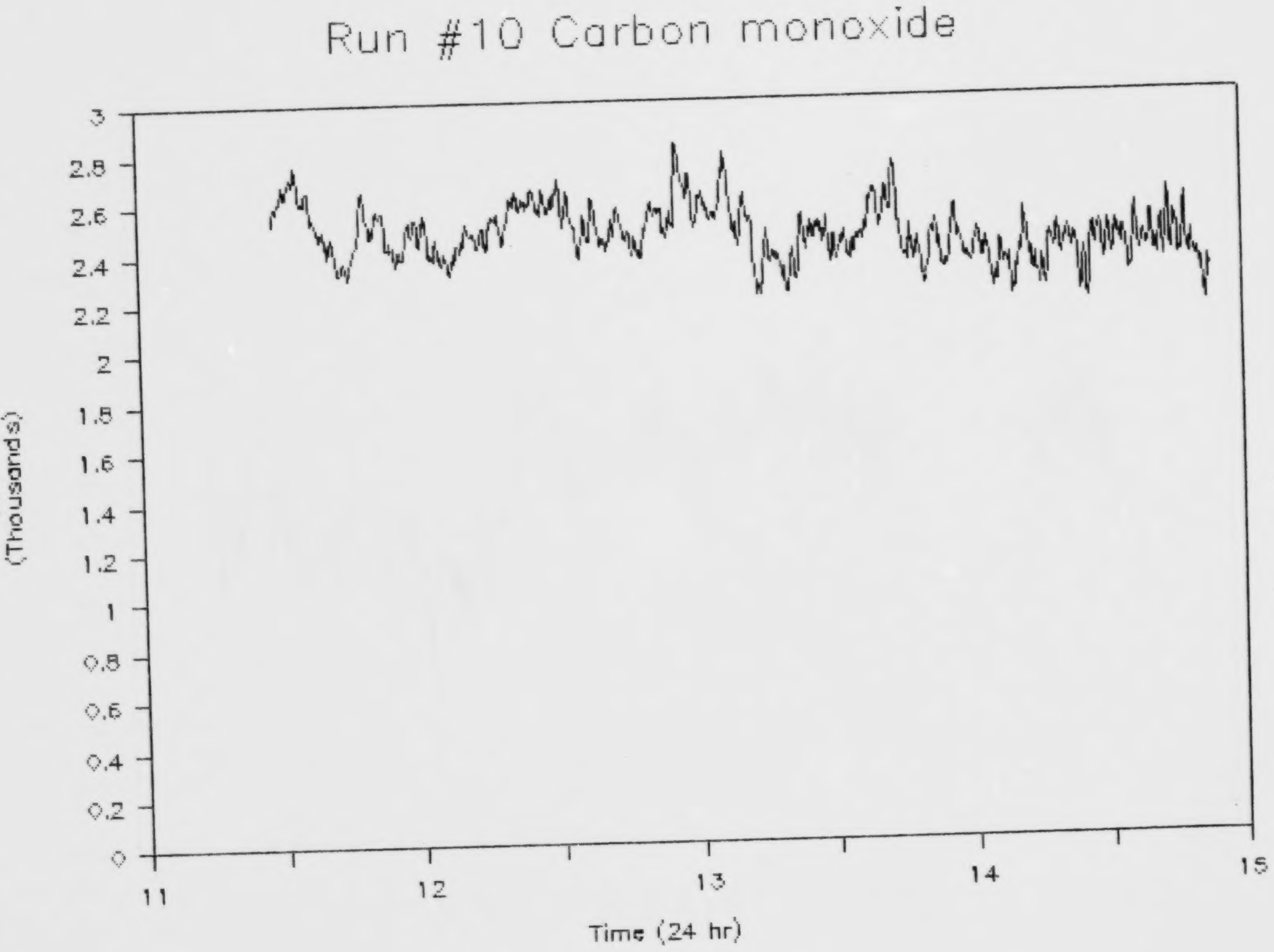
THC (Unheated)

Run #9, THC (Heated, wet)

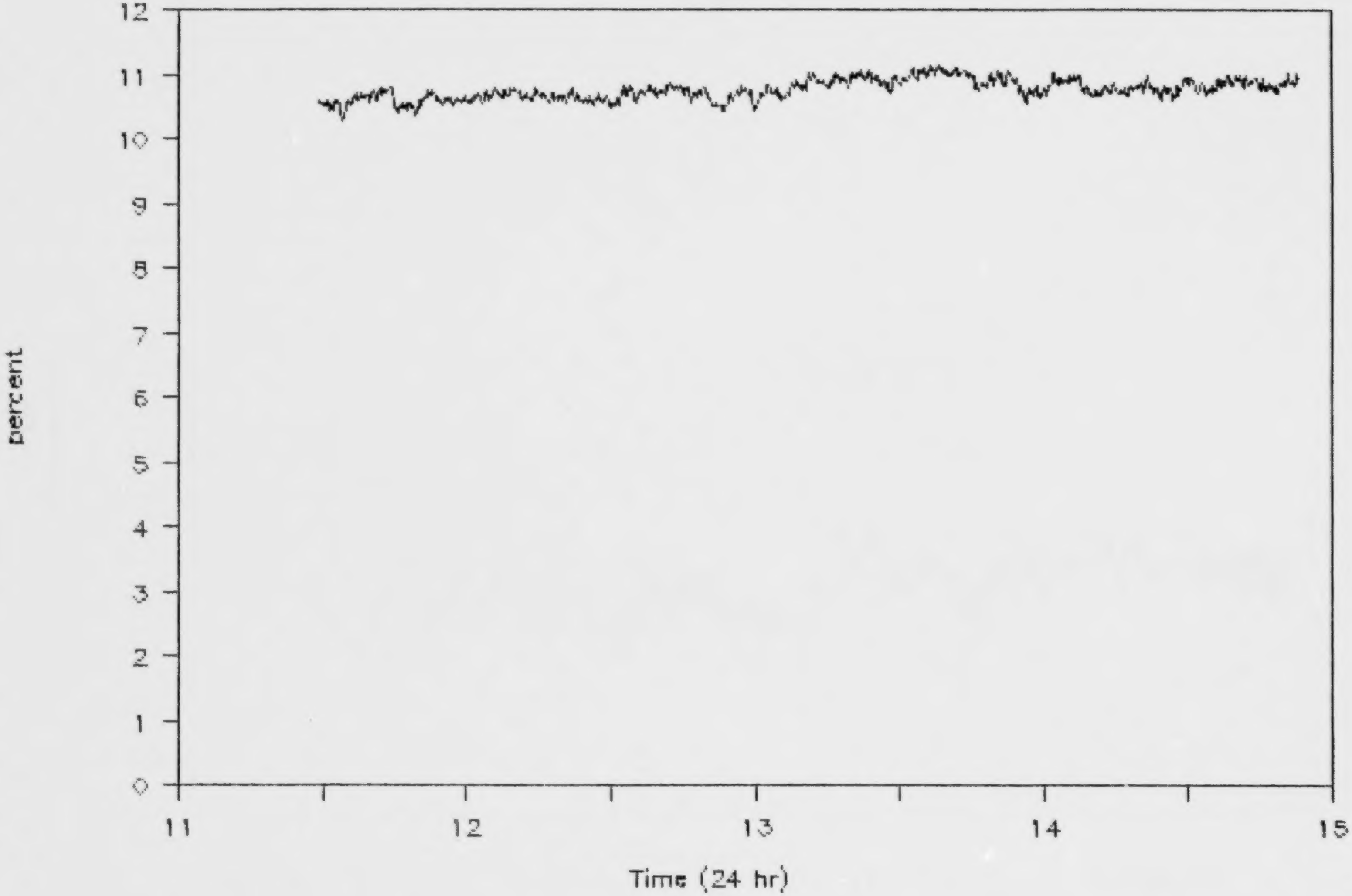


Run #9, THC (Unheated)

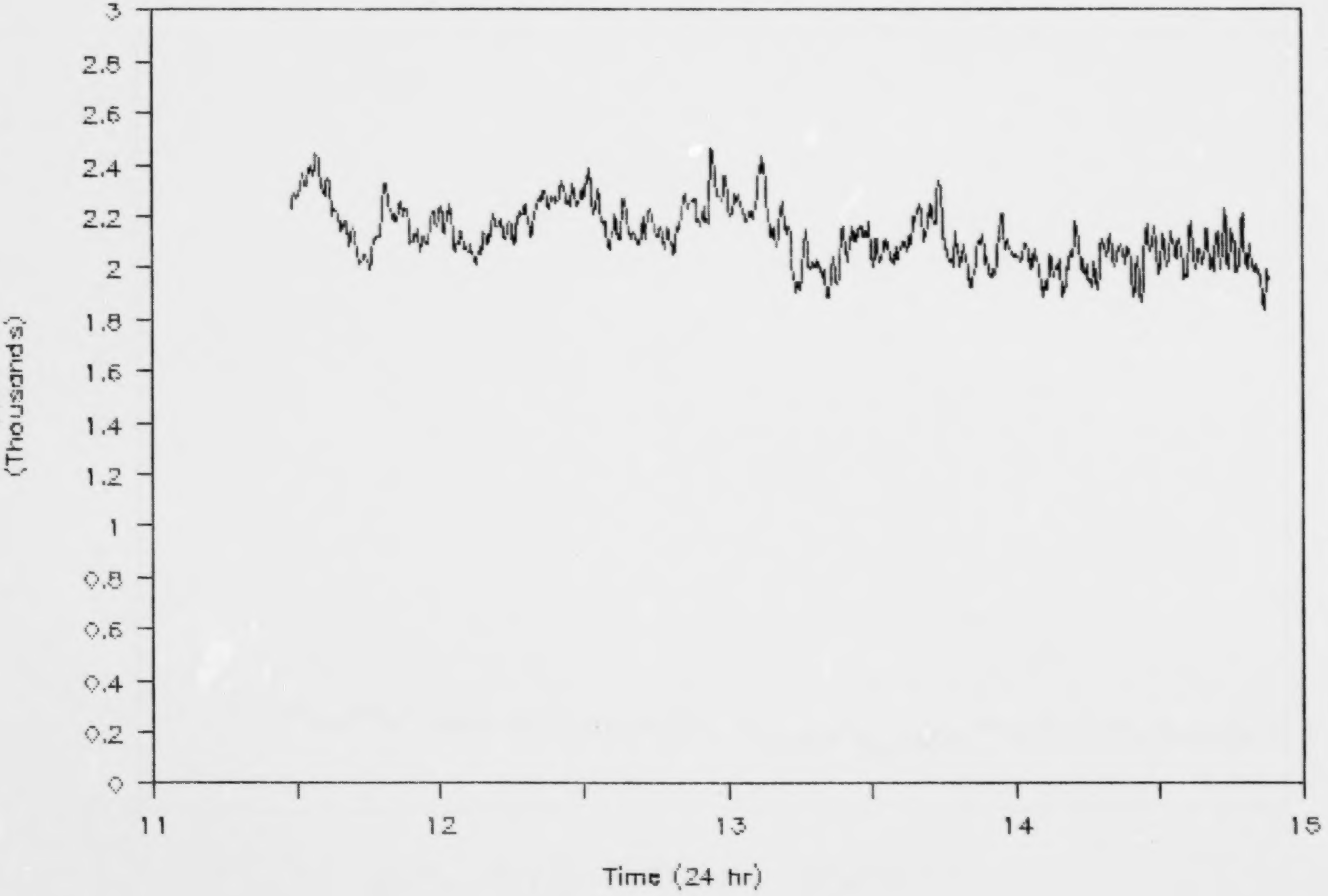



Run #10 Carbon monoxide
ppm
(Thousands)
3
2.8
2.6
2.4
2.2
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
11
12
13
14
15
Time (24 hr)

Run #10 Carbon dioxide

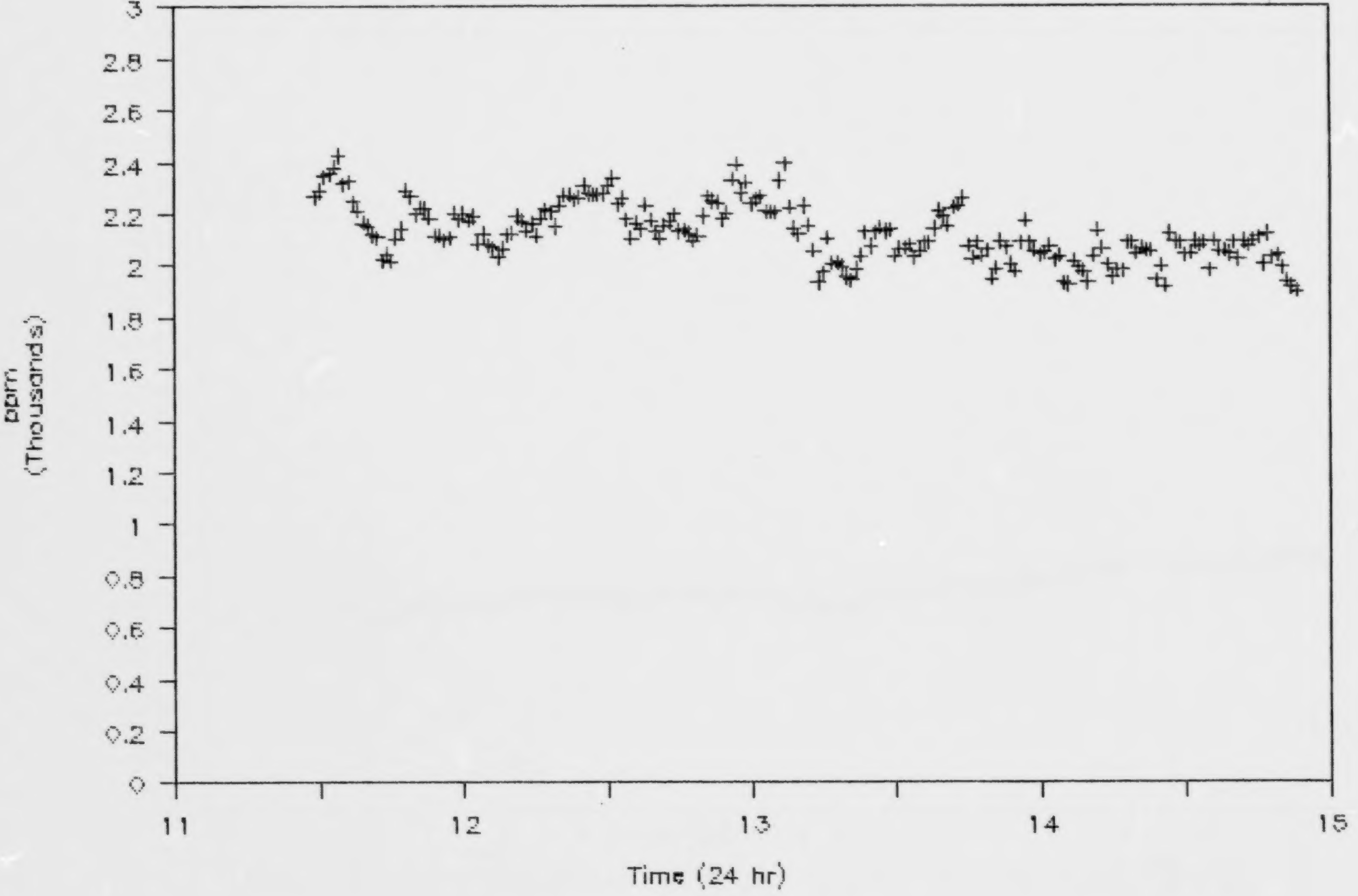


Run #10 Carbon monoxide (7% oxygen)



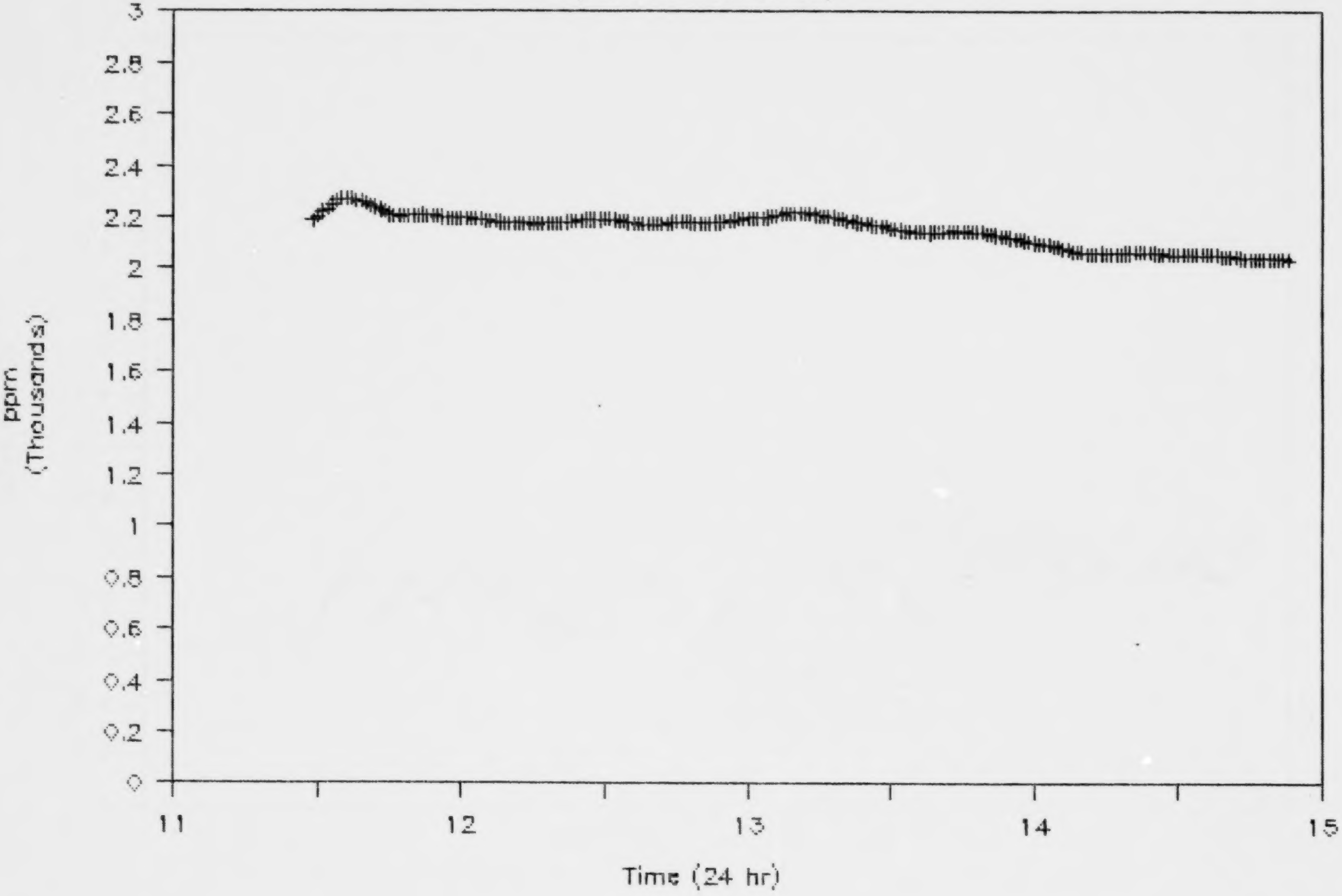
Run #10 Carbon monoxide, 1 min avg.

(corrected to 7% 02)

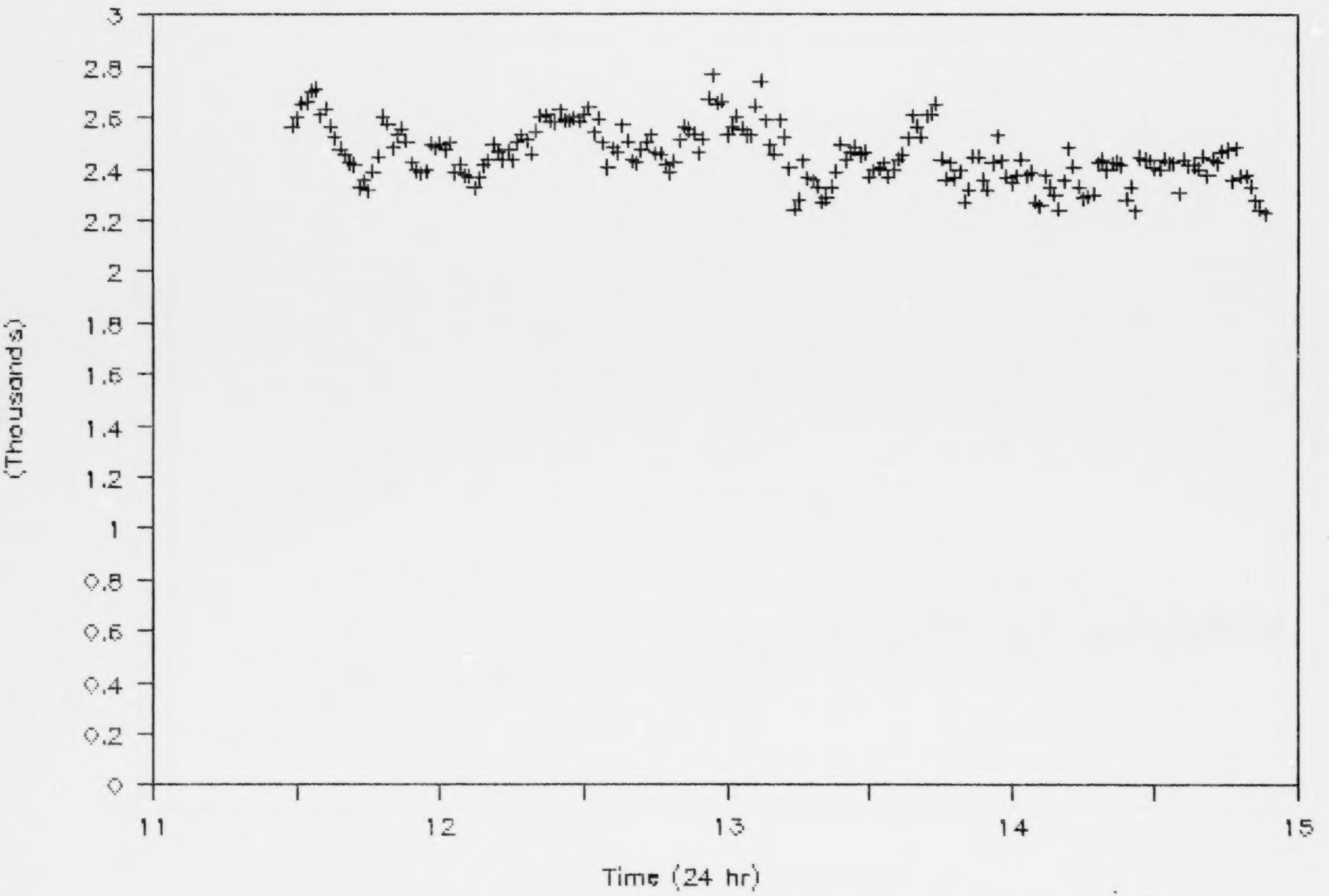


Run #10 Carbon monoxide, 1 hr roll.avg.

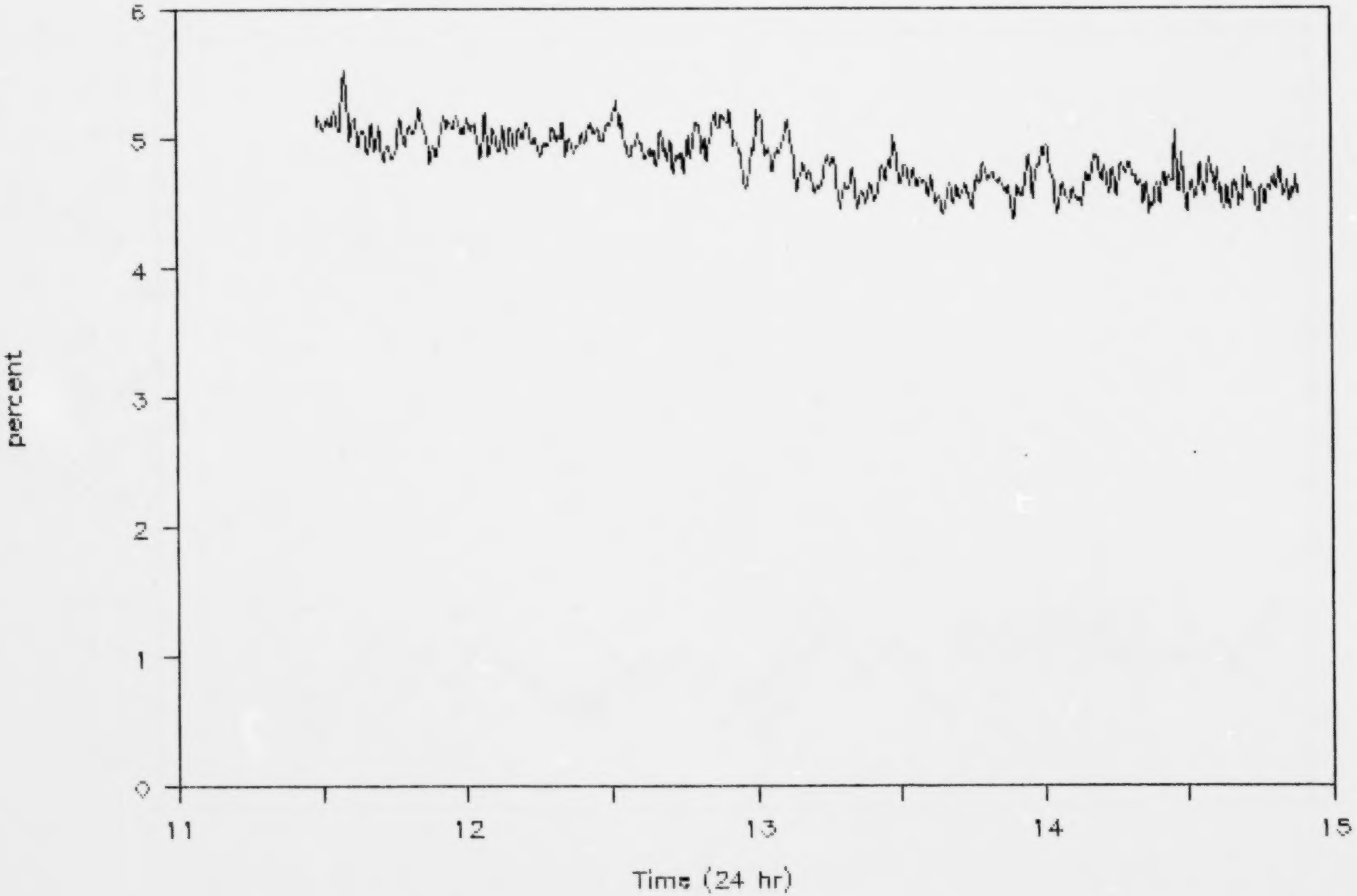
(corrected to 7% O2)



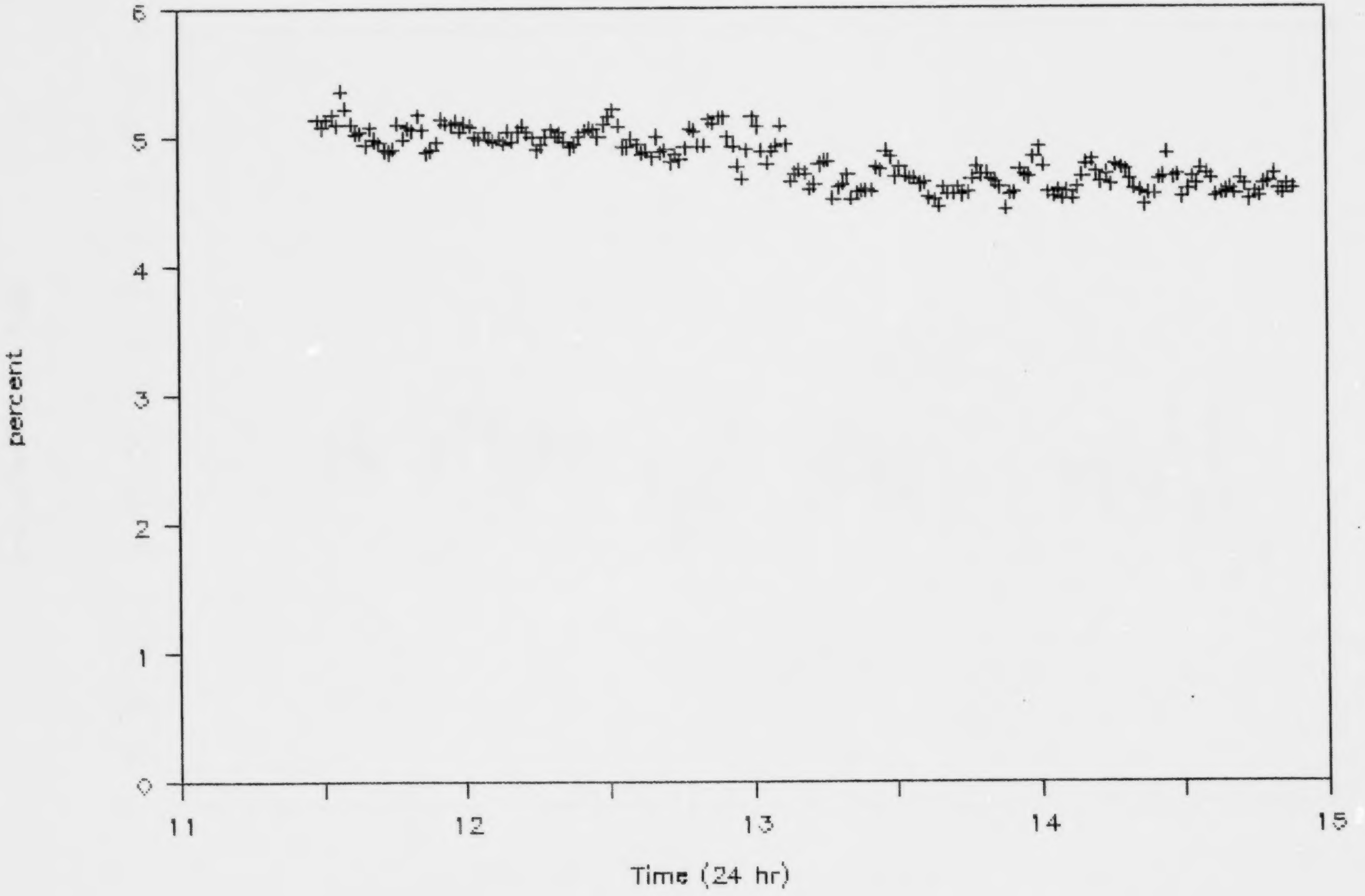
Run #10 Carbon monoxide, 1 min avg.



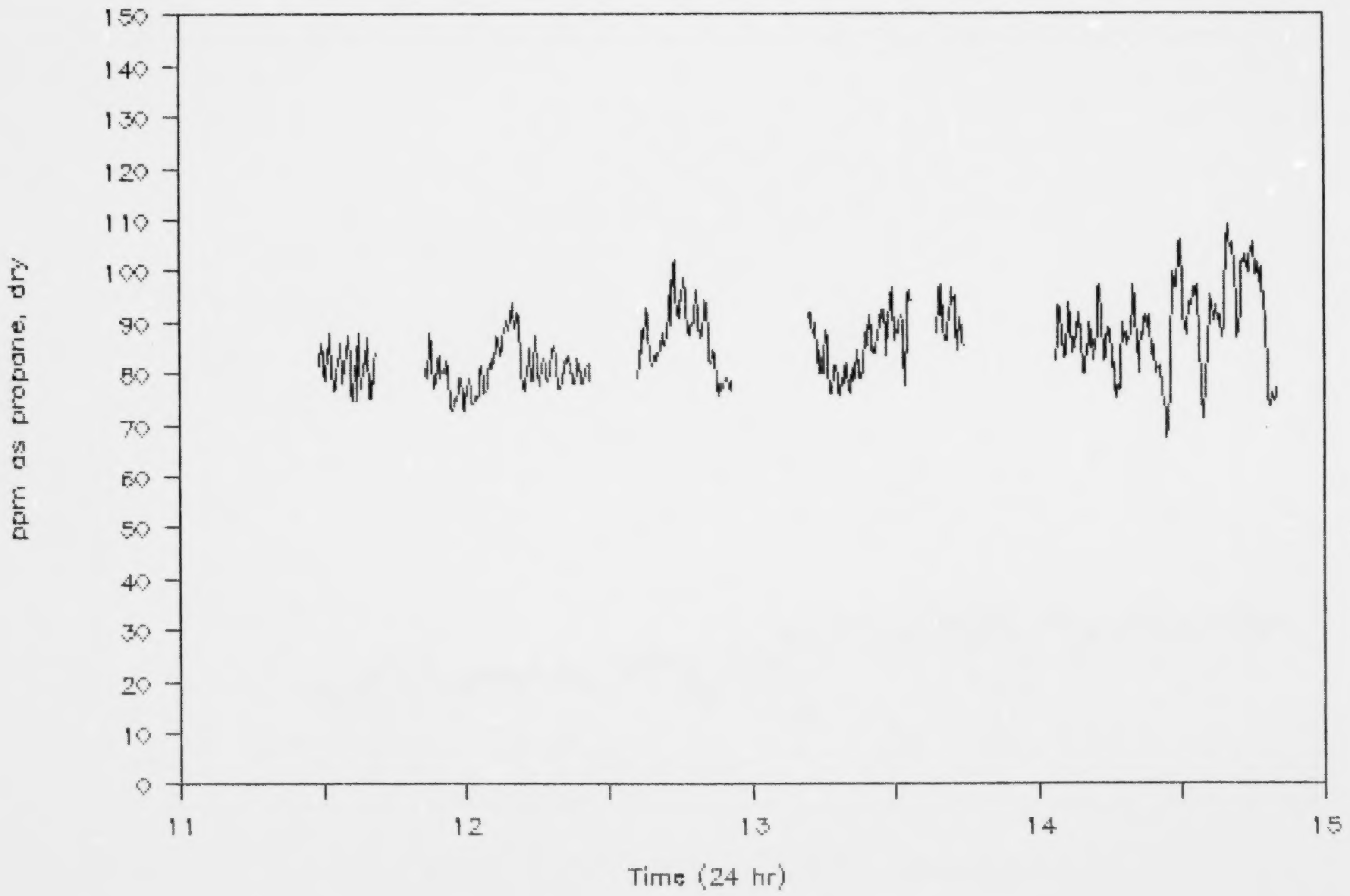
Run #10 Oxygen



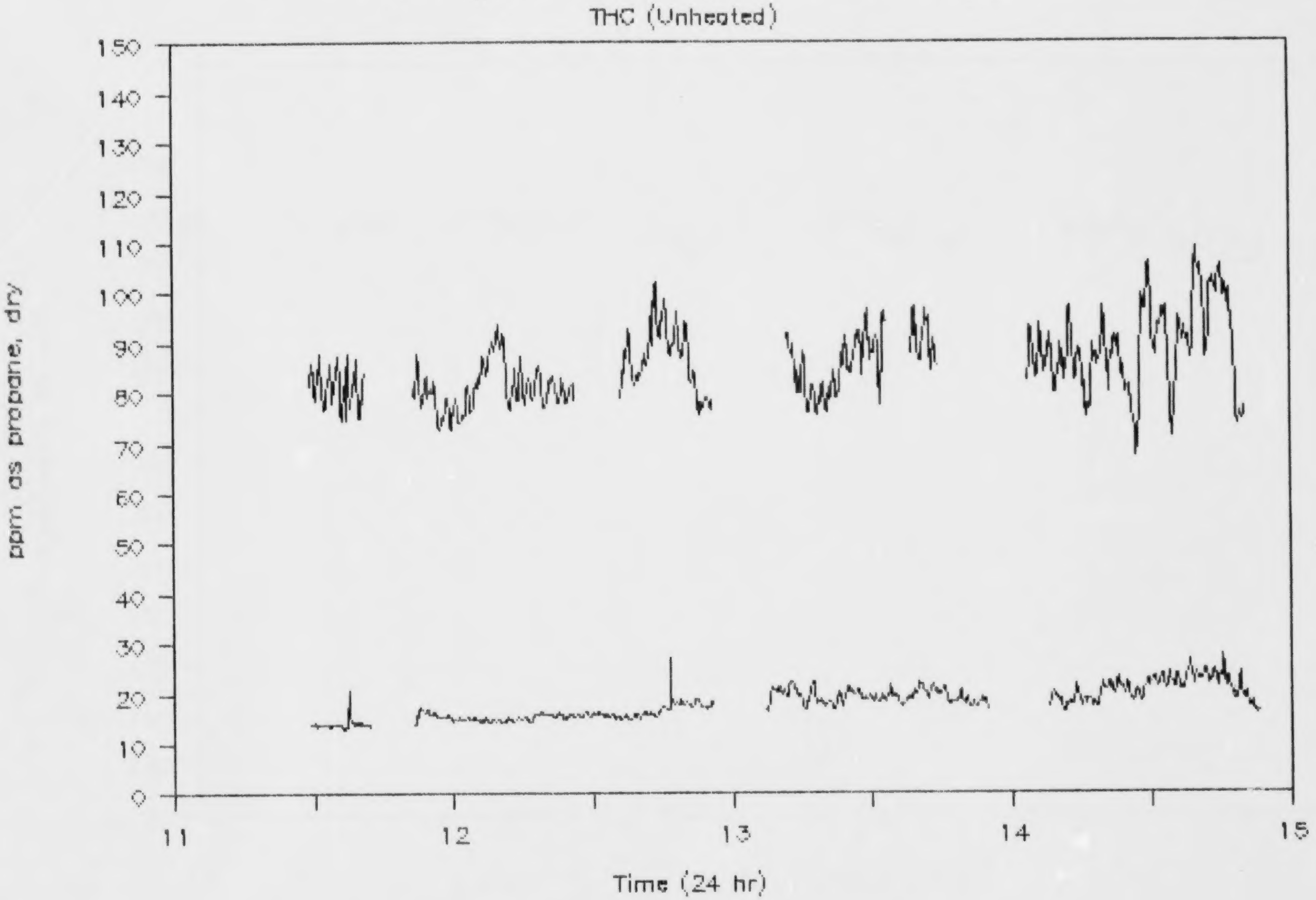
Run #10 Oxygen 1 min Averages



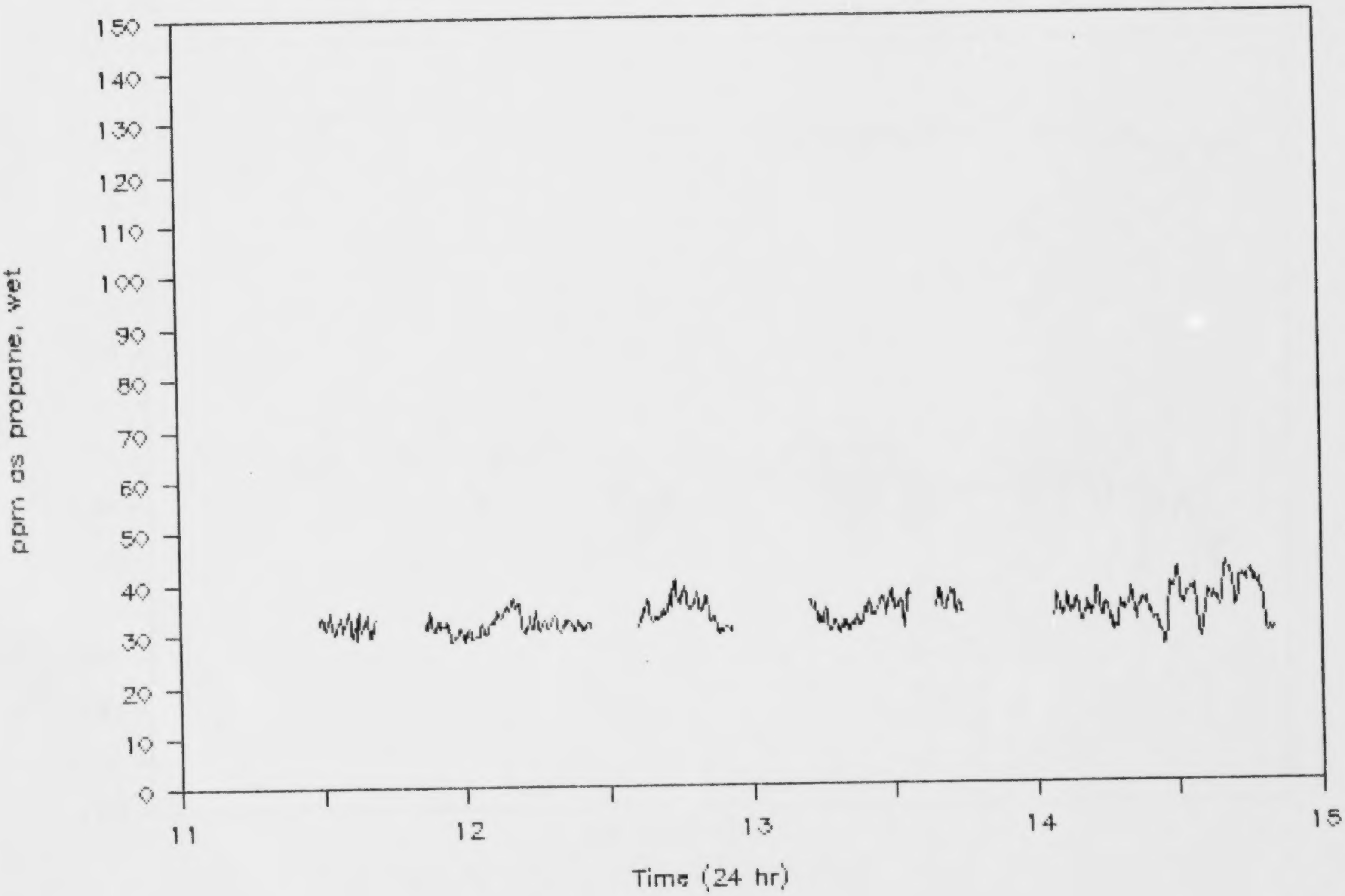
Run #10 THC (heated)



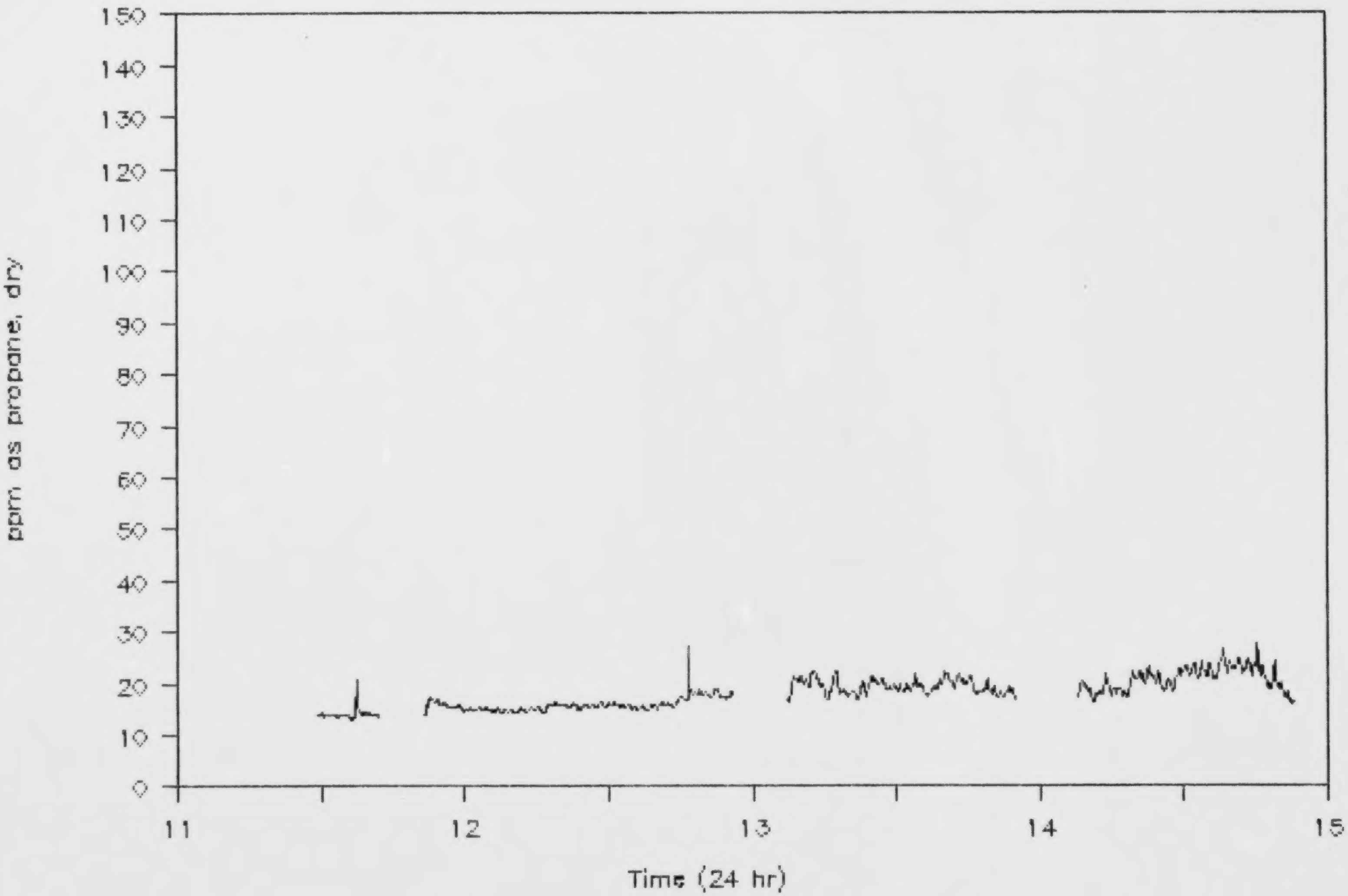
Run #10 THC (Heated, dry)



Run #10 THC (heated)



Run #10 THC (unheated)



APPENDIX B-2

PARTICULATE/PARTICLE SIZE DATA

Table B-2-1. M5 Data Summary
Table B-2-2. Method 3 (Orsat) Results
Table B-2-3. Process Feed Ash Analysis
Table B-2-4. Particulate Raw Data
Table B-2-5. Particle Size Results
Table B-2-6. Particle Size Raw Data

TABLE B-2-1. M5 DATA SUMMARY

Run	Sample volume (dscm)	Moisture (%)	Isokinetic (%)
1	2.227	55.3	99.9
2	2.217	59.0	99.3
3	2.184	55.6	99.5
4	2.203	59.6	100.1

TABLE B-2-2. METHOD 3 (Orsat) RESULTS

Run	CO_2 (%)	O_2 (%)
1	10.0	7.8
2	11.4	4.2
3	11.0	5.8
4	11.4	5.2

TABLE B-2-3. PROCESS FEED ASH ANALYSIS

Sample		% Ash
Run 1	Organic waste	0.136
	Aqueous waste	2.96
Run 2	Organic waste	0.045
	Aqueous waste	3.07
Run 3	Organic waste	0.064
	Aqueous waste	2.71
Run 4	Organic waste	0.034
	Aqueous waste	2.96

TABLE B-2-4. PARTICULATE RAW DATA

Run	Filter wt. (g)		Beaker wt. (g)		Particulate wt. (g)		
	Avg. initial wt.	Avg. final wt.	Avg. initial wt.	Avg. final wt.	Filter	Beaker	Total
1	1.0280	1.1144	92.8902	92.8984	0.0864	0.0082	0.0946
2	1.0171	1.1212	102.4311	102.4633	0.1041	0.0322	0.1363
3	1.0108	1.0997	103.5872	103.6071	0.0889	0.0199	0.1088
4	1.0266	1.1266	92.9302	92.9512	0.1000	0.0210	0.1210
Blank	1.0120	1.0124	100.9798	100.9800	0.0004	0.0002	0.0006
Proof	1.0088	1.0090	103.5034	103.5030	0.0002	-0.0004	-

TABLE B-2-5. PARTICLE SIZE RESULTS

PRELIMINARY RESULTS

Baseline Run

Stack Temperature: 182°F

Selected Stack Gas Parameters:

% Water = 52.8
% CO_2 = 10.0
% O_2 = 7.8

Test Sample Volume (Dry Std): 42.537 ft^3
% Isokinetic : 25.6
Loading (Dry): 0.02105 Grains/SCF

	Impactor Stage			
Results	1	2	Cyclone	Filter
Net Weight (mg) Corr.	3.20	2.20	2.85	49.78
Fraction (% of total)	5.51	3.79	4.91	85.78
Cumulative % (with filter)	5.51	9.31	14.22	100.00
D50 Size (microns)[1]	10.20	5.61	1.38	0.01
Geometric Mean Size (microns)	14.3	7.56	2.78	0.167

(continued)

TABLE B-2-5 (continued)

Run No. 4

Stack Temperature: 188°F
Selected Stack Gas Parameters:

% Water = 59.0
% CO_2 = 11.4
% O_2 = 5.2

Test Sample Volume (Dry Std): 43.096 ft^3
% Isokinetic: 26.9
Loading (Dry): 0.02823 Grains/SCF

	Impactor Stage			
Results	1	2	Cyclone	Filter
Net Weight (mg) Corr.	3.36	3.52	7.35	64.6
Fraction (% of total)	4.26	4.46	9.32	81.95
Cumulative % (with filter)	4.26	8.73	18.05	100.00
D50 Size (microns)[2]	9.61	5.22	1.22	0.01
Geometric Mean Size (microns)	13.9	7.08	2.53	0.160

---

[1] Assumed largest particle is 20 microns and 0.01 microns is smallest.
[2] Assumed largest particle is 20 microns and 0.01 microns is smallest.

Table B-2-6. Particle Size Raw Data

```
INPUT DATA FOR FILE MOBAHCSB
TEST DATE - 7-19-88                                  % WATER=                  52.80
PROJECT # - 9101L3614                                % CARBON DIOXIDE=         10.00
TEST SITE - MOBAY Incinerator Stack                  % CARBON MONOXIDE=         0.00
RUN ID     - 1-baseline                              % OXYGEN=                  7.80

                              ANDERSEN HCSS IMPACTOR

STACK TEMPERATURE= 182.0 DEGREES F.    SAMPLING TIME=  180.0 MIN.
BAR. PRESSURE=       29.22 INCHES HG   PRESSURE DROP=     0.00 INCHES HG
STATIC PRESSURE=     -0.15 INCHES H20  SAMPLER TEMP. = 205.0 DEGREES F.
AVE. DELTA P=         0.59 INCHES H20  PARTICLE DENS=    1
PITOT COEFF.=         .839             METER VOL.=       46.111 CUBIC FEET
METER TEMP.=         99.0 DEGREES F.   DELTA H=           0.18 INCHES H20
PROBE DIA.=           0.375 INCHES


                                  CALCULATED RESULTS

SAMPLE VOL.-DRY STD.=      42.537 CU. FT.DRY MOLECULAR WT.=      29.91
SAMPLE VOL.-WET STD.=      90.121 CU. FT.WET MOLECULAR WT.=      23.62
STACK VELOCITY=          3178.6 FT./MIN.  % ISOKINETIC=           25.6
NOZZLE VELOCITY=          813.4 FT./MIN.  SAMPLING RATE-ACTUAL=   0.624 CU. FT/MIN
MASS COLLECTED=            58.029 MG.     CYCLONE  BLANK=          0.000 MG.
LOADING=              0.00994 GRAIN/SCF   STAGE BLANK=             0.000 MG.
LOADING(DRY)=         0.02105 GRAIN/SCF   FILTER BLANK=            0.000 MG.

STAGE #                1          2       CYCLONE   FILTER
FINAL WT          10512.40   10557.75   10418.55  11922.85
 (MG)
TARE WT           10509.20   10555.55   10415.70  11873.07
 (MG)
NET WT                3.20       2.20       2.85     49.78
 (MG) CORRECTED
FRACTION              5.51       3.79       4.91     85.78
 % OF TOTAL
CUM. %                5.51       9.31      14.22    100.00
 WITH FILTER
FRACTION             38.79      26.67      34.54
 % WITHOUT FILTER
CUM. %               38.79      65.46     100.00
 WITHOUT FILTER

 JET VEL.                0         68        127
  (CM/SEC)
 D50 SIZE            10.20       5.61       1.38     <1.38
  (MICRONS)
 DM/DLOGD                     0.00145    0.00080
  (GRAINS/SCF)
 GEO MEAN                        7.56       2.78     <2.78
  (MICRONS)
 PARTICLE                   2.37D+04   3.57D+04
  COUNT
```

```
FILE NAME - MOBAHCSS                                          PROG.=VER 01/13/88 V2
RUN # - 1-baseline                                            07-25-1988  10:56:25
LOCATION - Incinerator Stack
DATE - 7-19-88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=               498.935
Final Meter Volume (Cubic Feet)=                 544.499
Meter Factor=                                      1.012
Final Leak Rate (cu ft/min)=                       0.000
Net Meter Volume (Cubic Feet)=                    46.111
Gas Volume (Dry Standard Cubic Feet)=             42.546

Barometric Pressure (in Hg)=                       29.22
Static Pressure (Inches H2O)=                      -0.15

Percent Oxygen=                                      7.8
Percent Carbon Dioxide=                             10.0
Moisture Collected (ml)=                          1012.4
Percent Water=                                      52.8

Average Meter Temperature (F)=                        99
Average Delta H (in H2O)=                           0.18
Average Delta P (in H2O)=                          0.594
Average Stack Temperature (F)=                       182

Dry Molecular Weight=                              29.91
Wet Molecular Weight=                              23.62

Average Square Root of Delta P (in H2O)=          0.7658
% Isokinetic=                                       25.6

Pitot Coefficient=                                  0.84
Sampling Time (Minutes)=                           180.0
Nozzle Diameter (Inches)=                          0.375
Stack Axis #1 (Inches)=                             35.6
Stack Axis #2 (Inches)=                             35.6
Rectangular Stack
Stack Area (Square Feet)=                           8.80

Stack Velocity  (Actual, Feet/min)=                3,180
Flow Rate (Actual, Cubic ft/min)=                 27,988
Flow rate (Standard, Wet, Cubic ft/min)=          22,458
Flow Rate (Standard, Dry, Cubic ft/min)=          10,589

Particulate Loading - Front Half

Particulate Weight (g)=                           0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=           0.0000         0.0000    0.0000
Particulate Loading, Actual (gr/cu ft)=           0.0000
Emission Rate (lb/hr)=                              0.00

No Back Half Analysis
```

```
                        * * METRIC UNITS * *
FILE NAME - MOBAHCSS                                    PROG.=VER 01/13/88 V2
RUN # - 1-baseline                                      07-25-1988  10:56:28
LOCATION - Incinerator Stack
DATE - 7-19-88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=          14.128
Final Meter Volume (Cubic Meters)=            15.418
Meter Factor=                                  1.012
Final Leak Rate (cu m/min)=                   0.0000
Net Meter Volume (Cubic Meters)=               1.306
Gas Volume (Dry Standard Cubic Meters)=        1.205

Barometric Pressure (mm Hg)=                     742
Static Pressure (mm H2O)=                         -4

Percent Oxygen=                                  7.8
Percent Carbon Dioxide=                         10.0
Moisture Collected (ml)=                      1012.4
Percent Water=                                  52.8

Average Meter Temperature (C)=                    37
Average Delta H (mm H2O)=                        4.6
Average Delta P (mm H2O)=                       15.1
Average Stack Temperature (C)=                    84

Dry Molecular Weight=                          29.91
Wet Molecular Weight=                          23.62

Average Square Root of Delta P (mm H2O)=      3.8596
% Isokinetic=                                   25.6

Pitot Coefficient=                              0.84
Sampling Time (Minutes)=                       180.0
Nozzle Diameter (mm)=                           9.52
Stack Axis #1 (Meters)=                        0.904
Stack Axis #2 (Meters)=                        0.904
Rectangular Stack
Stack Area (Square Meters)=                    0.818

Stack Velocity  (Actual, m/min)=                 969
Flow rate (Actual, Cubic m/min)=                 793
Flow rate (Standard, Wet, Cubic m/min)=          636
Flow rate (Standard, Dry, Cubic m/min)=          300

Particulate Loading - Front Half

Particulate Weight (g)=                       0.0000    Corr. to 7% O2 & 12% CC
Particulate Loading, Dry Std. (mg/cu m)=         0.0              0.0        0.0
Particulate Loading, Actual (mg/cu m)=           0.0
Emission Rate (kg/hr)=                          0.00

No Back Half Analysis
```

```
FILE NAME - MOBAHCSS                                       PROG.=VER 01/13/88 V2
RUN # - 1-baseline                                         07-25-1988  10:56:30
LOCATION - Incinerator Stack
DATE - 7-19-88
PROJECT # - 9101L3614

Point #      Delta P    Delta H    Stack T      Meter T
            (in. H2O)  (in. H2O)     (F)      In(F)  Out(F)
  1           0.740      0.18        183        88      87
  2           0.800      0.18        183        88      88
  3           0.820      0.18        184        90      89
  4           0.840      0.18        183        91      90
  5           0.850      0.18        183        92      91
  6           0.870      0.18        183        92      91
  7           0.860      0.18        183        94      93
  8           0.880      0.18        183        96      95
  9           0.860      0.18        183        97      96
 10           0.520      0.18        182        97      97
 11           0.480      0.18        184        96      94
 12           0.500      0.18        184        97      96
 13           0.520      0.18        184        97      97
 14           0.510      0.18        183        97      97
 15           0.510      0.18        183        97      97
 16           0.500      0.18        183        97      97
 17           0.500      0.18        182        97      97
 18           0.470      0.18        182        97      97
 19           0.490      0.18        182        98      98
 20           0.500      0.18        183        99      99
 21           0.500      0.18        183       101     101
 22           0.490      0.18        182       102     102
 23           0.490      0.18        182       102     102
 24           0.480      0.18        182       103     101
 25           0.490      0.18        182       103     102
 26           0.500      0.18        183       104     103
 27           0.520      0.18        183       105     104
 28           0.510      0.18        183       106     104
 29           0.530      0.18        183       107     105
 30           0.530      0.18        182       106     105
 31           0.540      0.18        181       106     105
 32           0.550      0.18        179       106     104
 33           0.560      0.18        179       106     104
 34           0.550      0.18        180       107     105
 35           0.560      0.18        181       107     105
 36           0.570      0.18        181       108     105


Fraction               Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                          (g)        (g)       (g)       (g)
DRY CATCH               0.0000     0.0000    0.0000    0.0000
FILTER                  0.0000     0.0000    0.0000    0.0000

Fraction               Final Wt.  Tare Wt.    Vol.     Net Wt.
                          (g)        (g)      (ml)       (g)
PROBE RINSE             0.0000     0.0000     0.0     0.0000
IMPINGERS               0.0000     0.0000     0.0     0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000
```

```
INPUT DATA FOR FILE MOBAHCS3
TEST DATE - 7-22-88                              % WATER=             59.00
PROJECT # - 9101L3614                            % CARBON DIOXIDE=    11.40
TEST SITE - MOBAY Incinerator Stack              % CARBON MONOXIDE=    0.00
RUN ID    - 4-particle sizing                    % OXYGEN=             5.20

                         ANDERSEN HCSS IMPACTOR

STACK TEMPERATURE= 188.0 DEGREES F.    SAMPLING TIME=  180.0 MIN.
BAR. PRESSURE=      29.38 INCHES HG    PRESSURE DROP=    0.00 INCHES HG
STATIC PRESSURE=    -0.15 INCHES H20   SAMPLER TEMP. = 191.0 DEGREES F.
AVE. DELTA P=        0.70 INCHES H20   PARTICLE DENS=    1
PITOT COEFF.=         .839             METER VOL.=      46.047 CUBIC FEET
METER TEMP.=        94.0 DEGREES F.    DELTA H=          0.18 INCHES H20
PROBE DIA.=          0.375 INCHES


                             CALCULATED RESULTS

SAMPLE VOL.-DRY STD.=    43.096 CU. FT.DRY MOLECULAR WT.=    30.03
SAMPLE VOL.-WET STD.=   105.112 CU. FT.WET MOLECULAR WT.=    22.93
STACK VELOCITY=        3541.6 FT./MIN. % ISOKINETIC=        26.9
NOZZLE VELOCITY=        952.3 FT./MIN. SAMPLING RATE-ACTUAL=  0.730 CU. FT/MIN
MASS COLLECTED=          78.828 MG.    CYCLONE  BLANK=        0.000 MG.
LOADING=             0.01157 GRAIN/SCF STAGE BLANK=           0.000 MG.
LOADING(DRY)=        0.02823 GRAIN/SCF FILTER BLANK=          0.000 MG.

STAGE #             1        2      CYCLONE   FILTER
FINAL WT       10375.68 10494.80 10517.10 11689.60
 (MG)
TARE WT        10372.32 10491.28 10509.75 11625.00
 (MG)
NET WT             3.36     3.52     7.35    64.60
 (MG) CORRECTED
FRACTION           4.26     4.46     9.32    81.95
 % OF TOTAL
CUM. %             4.26     8.73    18.05   100.00
 WITH FILTER
FRACTION          23.61    24.74    51.65
% WITHOUT FILTER
CUM. %            23.61    48.35   100.00
WITHOUT FILTER

JET VEL.              0       68      127
 (CM/SEC)
D50 SIZE           9.61     5.22     1.22    <1.22
 (MICRONS)
DM/DLOGD                 0.00195  0.00171
 (GRAINS/SCF)
GEO MEAN                    7.08     2.53    <2.53
 (MICRONS)
PARTICLE                3.41D+04 8.39D+04
 COUNT
```

```
FILE NAME - MOBHCSS3                                          PROG.=VER 01/13/88 V2
RUN # - 4-particle sizing                                     07-25-1988  11:42:10
LOCATION - Incinerator Stack
DATE - 7-22-88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=                  599.654
Final Meter Volume (Cubic Feet)=                    645.155
Meter Factor=                                         1.012
Final Leak Rate (cu ft/min)=                          0.000
Net Meter Volume (Cubic Feet)=                       46.047
Gas Volume (Dry Standard Cubic Feet)=                43.059

Barometric Pressure (in Hg)=                          29.38
Static Pressure (Inches H2O)=                         -0.15

Percent Oxygen=                                         5.2
Percent Carbon Dioxide=                                11.4
Moisture Collected (ml)=                             1316.5
Percent Water=                                         59.0

Average Meter Temperature (F)=                           94
Average Delta H (in H2O)=                              0.18
Average Delta P (in H2O)=                             0.706
Average Stack Temperature (F)=                          188

Dry Molecular Weight=                                 30.03
Wet Molecular Weight=                                 22.93

Average Square Root of Delta P (in H2O)=             0.8391
% Isokinetic=                                          26.9

Pitot Coefficient=                                     0.84
Sampling Time (Minutes)=                              180.0
Nozzle Diameter (Inches)=                             0.375
Stack Axis #1 (Inches)=                                35.6
Stack Axis #2 (Inches)=                                35.6
Rectangular Stack
Stack Area (Square Feet)=                              8.80

Stack Velocity  (Actual, Feet/min)=                   3,543
Flow Rate (Actual, Cubic ft/min)=                    31,181
Flow rate (Standard, Wet, Cubic ft/min)=             24,926
Flow Rate (Standard, Dry, Cubic ft/min)=             10,216

Particulate Loading - Front Half

Particulate Weight (g)=                              0.0000   Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=              0.0000        0.0000     0.0000
Particulate Loading, Actual (gr/cu ft)=              0.0000
Emission Rate (lb/hr)=                                 0.00

No Back Half Analysis
```

```
                        * * METRIC UNITS * *
FILE NAME - MOBHCSS3                                     PROG.=VER 01/13/88 V2
RUN # - 4-particle sizing                                07-25-1988  11:42:12
LOCATION - Incinerator Stack
DATE - 7-22-88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=                 16.980
Final Meter Volume (Cubic Meters)=                   18.268
Meter Factor=                                         1.012
Final Leak Rate (cu m/min)=                          0.0000
Net Meter Volume (Cubic Meters)=                      1.304
Gas Volume (Dry Standard Cubic Meters)=               1.219

Barometric Pressure (mm Hg)=                            746
Static Pressure (mm H2O)=                                -4

Percent Oxygen=                                         5.2
Percent Carbon Dioxide=                                11.4
Moisture Collected (ml)=                             1316.5
Percent Water=                                         59.0

Average Meter Temperature (C)=                           35
Average Delta H (mm H2O)=                               4.6
Average Delta P (mm H2O)=                              17.9
Average Stack Temperature (C)=                           87

Dry Molecular Weight=                                 30.03
Wet Molecular Weight=                                 22.93

Average Square Root of Delta P (mm H2O)=             4.2292
% Isokinetic=                                          26.9

Pitot Coefficient=                                     0.84
Sampling Time (Minutes)=                              180.0
Nozzle Diameter (mm)=                                  9.52
Stack Axis #1 (Meters)=                               0.904
Stack Axis #2 (Meters)=                               0.904
Rectangular Stack
Stack Area (Square Meters)=                           0.818

Stack Velocity  (Actual, m/min)=                      1,080
Flow rate (Actual, Cubic m/min)=                        883
Flow rate (Standard, Wet, Cubic m/min)=                 706
Flow rate (Standard, Dry, Cubic m/min)=                 289

Particulate Loading - Front Half

Particulate Weight (g)=                              0.0000   Corr. to 7% O2 & 12% CC
Particulate Loading, Dry Std. (mg/cu m)=                0.0            0.0        0.0
Particulate Loading, Actual (mg/cu m)=                  0.0
Emission Rate (kg/hr)=                                 0.00

No Back Half Analysis
```

FILE NAME - MOBHCSS3
RUN # - 4-particle sizing
LOCATION - Incinerator Stack
DATE - 7-22-88
PROJECT # - 9101L3614

PROG.=VER 01/13/88 V2
07-25-1988 11:42:14

Point #	Delta P	Delta H	Stack T	Meter T	
	(in. H2O)	(in. H2O)	(F)	In(F)	Out(F)
1	0.790	0.18	186	84	83
2	0.790	0.18	187	84	83
3	0.750	0.18	190	89	88
4	0.720	0.18	189	91	88
5	0.830	0.18	187	92	89
6	0.780	0.18	187	94	91
7	0.790	0.18	188	95	93
8	0.770	0.18	190	96	94
9	0.740	0.18	190	98	97
10	0.770	0.18	189	97	96
11	0.790	0.18	188	97	96
12	0.700	0.18	187	96	96
13	0.600	0.18	188	97	96
14	0.610	0.18	187	96	94
15	0.760	0.18	187	96	94
16	0.700	0.18	190	97	94
17	0.720	0.18	187	96	93
18	0.730	0.18	188	97	95
19	0.740	0.18	187	96	95
20	0.750	0.18	188	98	98
21	0.750	0.18	187	95	95
22	0.720	0.18	187	95	93
23	0.760	0.18	189	98	96
24	0.700	0.18	187	97	96
25	0.700	0.18	188	99	99
26	0.710	0.18	188	100	100
27	0.640	0.18	187	93	90
28	0.670	0.18	189	93	91
29	0.630	0.18	188	93	91
30	0.640	0.18	190	95	94
31	0.610	0.18	191	97	96
32	0.640	0.18	189	97	96
33	0.610	0.18	190	97	97
34	0.610	0.18	189	96	96
35	0.620	0.18	189	97	96
36	0.570	0.18	192	98	97

Fraction	Final Wt. (g)	Tare Wt. (g)	Blank Wt. (g)	Net Wt. (g)
DRY CATCH	0.0000	0.0000	0.0000	0.0000
FILTER	0.0000	0.0000	0.0000	0.0000

Fraction	Final Wt. (g)	Tare Wt. (g)	Vol. (ml)	Net Wt. (g)
PROBE RINSE	0.0000	0.0000	0.0	0.0000
IMPINGERS	0.0000	0.0000	0.0	0.0000

Probe Rinse Blank (mg/ml)= 0.0000
Impinger Blank (mg/ml)= 0.0000

APPENDIX B-3

METALS DATA

Table B-3-1. Process Stream Metals Data
Table B-3-2. Metals Spiking Data
Table B-3-3. Metals Particle Size Data
Table B-3-4. MM5 Metals Train Raw Data
Table B-3-5. MM5 Raw Data

TABLE B-3-1. PROCESS STREAM METALS DATA

Sample name	Specific gravity	Feedrate		Concentration (mcg/g - mg/kg)			
		(gal/min)	(kg/min)	As	Cd	Cr	Pb
Run 1 (baseline)							
Organic waste	0.97	3.0	11	< 24.6	< 0.167	5.16	< 6.00
Aqueous waste	1.04	6.4	25	1.42	0.0267	0.250	0.0896
Tempering water[a]	1.00	0	0	< 0.000664	0.0100	0.0308	0.0884
Quench water[a]	1.00	47	178	< 0.000664	0.0100	0.0308	0.0884
Scrubber water[a]	1.00	60	227	< 0.000664	0.0100	0.0308	0.0884
Scrubber alkali	1.53	1.3	7	< 0.352	< 0.0363	0.942	9.81
Run 2							
Organic waste	0.97	3.3	12	< 4.27	< 0.0291	1.64	< 1.04
Aqueous waste	1.04	6.8	27	3.04	< 0.00172	0.265	0.446
Metals spike	-	-	0.05073	< 0.339	2,200	5,700	759
Tempering water[a]	1.00	2.0	7.6	< 0.000664	0.0100	0.0308	0.0884
Quench water[a]	1.00	46	174	< 0.000664	0.0100	0.0308	0.0884
Scrubber water[a]	1.00	43	163	< 0.000664	0.0100	0.0308	0.0884
Scrubber alkali	1.53	2.0	11	0.644	0.0217	0.845	< 0.256
Run 3							
Organic waste	0.97	3.0	11	< 4.11	< 0.0279	1.65	< 1.00
Aqueous waste	1.04	6.4	25	2.64	0.0122	0.131	0.167
Metals spike	-	-	0.06155	< 0.311	1,990	10,500	735
Tempering water[a]	1.00	2.0	7.6	< 0.000664	0.0100	0.0308	0.0884
Quench water[a]	1.00	47	178	< 0.000664	0.0100	0.0308	0.0884
Scrubber water	1.00	43	163	< 0.000664	0.0100	0.0308	0.0884
Scrubber alkali	1.53	1.8	10	0.975	< 0.0606	0.472	0.832

(continued)

TABLE B-3-1 (continued)

Sample name	Specific gravity	Feedrate (gal/min)	Feedrate (kg/min)	Concentration (mcg/g - mg/kg) As	Concentration (mcg/g - mg/kg) Cd	Concentration (mcg/g - mg/kg) Cr	Concentration (mcg/g - mg/kg) Pb
Run 4							
Organic waste	0.97	3.0	11	< 2.49	< 0.0264	1.02	< 0.945
Aqueous waste	1.04	6.0	24	2.62	< 0.00165	0.290	0.293
Metals spike	-	-	0.06742	0.632	1,710	4,390	523
Tempering water[a]	1.00	2.0	7.6	< 0.000664	0.0100	0.0308	0.0884
Quench water[a]	1.00	48	182	< 0.000664	0.0100	0.0308	0.0884
Scrubber water	1.00	58	220	< 0.000664	0.0100	0.0308	0.0884
Scrubber alkali	1.53	1.8	10	0.460	0.104	0.818	3.23

[a] Analysis results for single grab sample of city water used for all four runs.

TABLE B-3-2. METALS SPIKING DATA

Run	Concentration (μg/g)			
	As	Cd	Cr	Pb
2	< 0.339	2,200	5,700	759
3	< 0.311	1,990	10,500	735
4	0.632	1,710	4,390	523

TABLE B-3-3. METALS PARTICLE SIZE DATA

Sample name	Size range of fraction, microns	D50 size, microns	Geometric mean diameter, microns	Amount in sample,)g				Distribution by particle size, $					Cumulative distribution by particle size, $ less than D50				
				As	Cd	Cr	Pb	As	Cd	Cr	Pb	Part.	As	Cd	Cr	Pb	Part.
Run 1																	
HCSS Stage 1	> 10	10.20	14.3	< 0.0937	0.282	4.09	0.383	0	25	9	2	5	100	75	91	98	95
HCSS Stage 2	5-10	5.61	7.56	< 0.0937	0.166	2.48	0.562	0	15	6	3	4	100	61	85	95	91
HCSS Cyclone	1-5	1.38	2.78	< 0.0937	0.192	6.20	0.141	0	17	14	1	5	100	44	71	94	86
HCSS Final Filter	< 1	0.01	0.167	1.81	0.500	30.8	17.7	100	44	71	94	86					
Total Detected				1.81	1.14	43.5	18.8										
Run 4																	
HCSS Stage 1	> 10	9.61	13.9	0.211	1.08	20.0	1.38	4	7	8	7	4	96	93	92	93	96
HCSS Stage 2	5-10	5.22	7.08	1.06	0.614	32.2	0.256	20	4	13	1	5	75	89	79	92	91
HCSS Cyclone	1-5	1.22	2.53	0.365	5.43	109	0.652	7	35	43	3	9	68	54	37	88	82
HCSS Final Filter	< 1	0.01	0.160	3.54	8.31	93.5	17.5	68	54	37	88	82					
Total Detected				5.17	15.4	255	19.8										

TABLE B-3-4. MM5 METALS TRAIN RAW DATA

Sample	Quantity (μg)			
	As	Cd	Cr	Pb
Run 1				
Front half	5.26	1.58	12.4	16.2
Back half	0.326	8.21	4.49	17.5
Total	5.59	9.80	16.9	33.7
Run 2				
Front half	7.01	10.1	24.9	7.53
Back half	3.53	5.26	2.87	16.2
Total	10.5	15.3	27.8	23.7
Run 3				
Front half	9.18	13.3	49.2	7.17
Back half	0.258	5.26	3.08	15.0
Total	9.44	18.5	52.3	22.1
Run 4				
Front half	9.84	16.0	39.2	9.01
Back half	0.189	4.98	9.00	9.60
Total	10.0	21.0	48.2	18.6
Train proof blanks				
Front half	0.557	0.110	4.55	15.0
Back half	0.134	0.739	0.367	1.65
Total	0.691	0.849	4.92	16.6
Reagent blanks				
Acetone/filter	1.13	0.840	2.90	2.31
$0.1N/HNO_3$	< 0.0937	0.0119	0.254	0.588
HNO_3/H_2O_2	0.00102	0.000184	0.000225	0.247
Total	1.13	0.852	3.16	3.15

Table B-3-5. MM5 Raw Data

```
FILE NAME - mobmet1                                          PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 1 (BACKGROUND)                      08-10-1988  09:48:57
LOCATION - Mobay Kansas City MO
DATE - 7/19/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=              385.645
Final Meter Volume (Cubic Feet)=                468.824
Meter Factor=                                     1.018
Multiple leak checks, see end of printout                 Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                   84.660
Gas Volume (Dry Standard Cubic Feet)=            78.647

Barometric Pressure (in Hg)=                      29.22
Static Pressure (Inches H2O)=                     -0.15

Percent Oxygen=                                     7.8
Percent Carbon Dioxide=                            10.0
Moisture Collected (ml)=                         2067.7
Percent Water=                                     55.3

Average Meter Temperature (F)=                       96
Average Delta H (in H2O)=                          0.57
Average Delta P (in H2O)=                         0.474
Average Stack Temperature (F)=                      183

Dry Molecular Weight=                             29.91
Wet Molecular Weight=                             23.32

Average Square Root of Delta P (in H2O)=         0.6857
% Isokinetic=                                      99.9

Pitot Coefficient=                                 0.84
Sampling Time (Minutes)=                          192.0
Nozzle Diameter (Inches)=                         0.271
Stack Axis #1 (Inches)=                            35.6
Stack Axis #2 (Inches)=                            35.6
Circular Stack
Stack Area (Square Feet)=                          6.91

Stack Velocity  (Actual, Feet/min)=               2,855
Flow Rate (Actual, Cubic ft/min)=                19,737
Flow rate (Standard, Wet, Cubic ft/min)=         15,834
Flow Rate (Standard, Dry, Cubic ft/min)=          7,074

Particulate Loading - Front Half

Particulate Weight (g)=                          0.0942      Corr. to 7% O2
Particulate Loading, Dry Std. (gr/scf)=          0.0184    0.0196
Particulate Loading, Actual (gr/cu ft)=          0.0066
Emission Rate (lb/hr)=                             1.12

No Back Half Analysis
```

```
                          * * METRIC UNITS * *
FILE NAME - mobmet1                                          PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 1 (BACKGROUND)                      08-10-1988  09:49:25
LOCATION - Mobay Kansas City MO
DATE - 7/19/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=               10.920
Final Meter Volume (Cubic Meters)=                 13.275
Meter Factor=                                       1.018
Multiple leak checks, see end of printout                 Leak Correction=  0.0000
Net Meter Volume (Cubic Meters)=                    2.397
Gas Volume (Dry Standard Cubic Meters)=             2.227

Barometric Pressure (mm Hg)=                          742
Static Pressure (mm H2O)=                              -4

Percent Oxygen=                                       7.8
Percent Carbon Dioxide=                              10.0
Moisture Collected (ml)=                           2067.7
Percent Water=                                       55.3

Average Meter Temperature (C)=                         35
Average Delta H (mm H2O)=                            14.5
Average Delta P (mm H2O)=                            12.0
Average Stack Temperature (C)=                         84

Dry Molecular Weight=                               29.91
Wet Molecular Weight=                               23.32

Average Square Root of Delta P (mm H2O)=           3.4558
  Isokinetic=                                        99.9

Pitot Coefficient=                                   0.84
Sampling Time (Minutes)=                            192.0
Nozzle Diameter (mm)=                                6.88
Stack Axis #1 (Meters)=                             0.904
Stack Axis #2 (Meters)=                             0.904
Circular Stack
Stack Area (Square Meters)=                         0.642

Stack Velocity  (Actual, m/min)=                      870
Flow rate (Actual, Cubic m/min)=                      559
Flow rate (Standard, Wet, Cubic m/min)=               448
Flow rate (Standard, Dry, Cubic m/min)=               200

Particulate Loading - Front Half

Particulate Weight (g)=                               0.1        Corr. to 7% O2
Particulate Loading, Dry Std. (mg/cu m)=             42.3         44.9
Particulate Loading, Actual (mg/cu m)=               15.2
Emission Rate (kg/hr)=                               0.51

No Back Half Analysis
```

```
FILE NAME - mobmet1                                           PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 1 (BACKGROUND)                       08-10-1988  09:49:52
LOCATION - Mobay Kansas City MO
DATE - 7/19/88
PROJECT # - 9101L3614

 int #      Delta P     Delta H    Stack T       Meter T
           (in. H2O)  (in. H2O)     (F)     In(F)   Out(F)
  1          0.300       0.37       182       91       91
  2          0.290       0.33       182       91       91
  3          0.380       0.43       183       92       91
  4          0.360       0.45       183       94       92
  5          0.460       0.56       183       95       92
  6          0.460       0.53       183       96       93
  7          0.520       0.65       182       97       94
  8          0.460       0.55       183       98       95
  9          0.530       0.66       183       99       95
  10         0.540       0.66       183      100       96
  11         0.530       0.66       183      100       97
  12         0.510       0.66       182      100       98
  13         0.610       0.81       181      100       98
  14         0.580       0.73       182      100       98
  15         0.620       0.79       182      100       98
  16         0.610       0.80       181      100       98
  17         0.590       0.74       182      100       98
  18         0.580       0.73       182      100       98
  19         0.410       0.51       182      100       99
  20         0.410       0.47       183       99       99
  21         0.380       0.46       182       99       99
  22         0.390       0.46       183       99       99
  23         0.410       0.47       183       99      100
   4         0.410       0.47       183      100      100
  25         0.490       0.55       184       88       89
  26         0.490       0.54       184       89       89
  27         0.520       0.61       183       90       89
  28         0.520       0.62       183       92       89
  29         0.550       0.64       183       93       90
  30         0.540       0.64       183       94       91
  31         0.520       0.61       183       94       91
  32         0.520       0.60       183       95       91
  33         0.520       0.60       183       95       92
  34         0.510       0.59       183       96       92
  35         0.520       0.63       182       96       93
  36         0.510       0.60       183       96       93
  37         0.520       0.63       182       97       94
  38         0.520       0.60       183       97       94
  39         0.480       0.59       182       97       96
  40         0.500       0.61       182       97       96
```

```
FILE NAME - mobmet1                                          PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 1 (BACKGROUND)                      08-10-1988  09:50:21
LOCATION - Mobay Kansas City MO
DATE - 7/19/88
PROJECT # - 9101L3614

  1          0.480       0.60      182       97       96
 42          0.510       0.63      182       97       96
 43          0.450       0.52      183       98       97
 44          0.440       0.51      183       98       97
 45          0.370       0.44      182       97       96
 46          0.380       0.47      182       97       96
 47          0.290       0.36      181       97       96
 48          0.280       0.35      181       97       97


Fraction                 Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                           (g)        (g)        (g)       (g)
DRY CATCH                0.0000     0.0000     0.0000    0.0000
FILTER                   1.1144     1.0280     0.0004    0.0860

Fraction                 Final Wt.  Tare Wt.    Vol.     Net Wt.
                           (g)        (g)       (ml)       (g)
PROBE RINSE             92.8984    92.8902     100.0    0.0082
IMPINGERS                0.0000     0.0000       0.0    0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.0020    96.0000
    0.0010    96.0000
```

```
FILE NAME - mobchr1                                       PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 1 (BACKGROUND)                 08-10-1988  10:14:31
LOCATION - Mobay Kansas City MO
DATE - 7/19/88
PROJECT # - 9101L3614


 .rometric Pressure (in Hg)=                     29.22
Static Pressure (Inches H2O)=                    -0.15

Percent Oxygen=                                    7.8
Percent Carbon Dioxide=                           10.0
Moisture Collected (ml)=                        1871.3
Percent Water=                                    53.2

Average Delta P (in H2O)=                        0.417
Average Stack Temperature (F)=                     181

Dry Molecular Weight=                            29.91
Wet Molecular Weight=                            23.58

Average Square Root of Delta P (in H2O)=        0.6375
Pitot Coefficient=                                0.83
Stack Axis #1 (Inches)=                           35.6
Stack Axis #2 (Inches)=                           35.6
Circular Stack
Stack Area (Square Feet)=                         6.91

Stack Velocity  (Actual, Feet/min)=              2,631
Flow Rate (Actual, Cubic ft/min)=               18,188
Flow rate (Standard, Wet, Cubic ft/min)=        14,623
Flow Rate (Standard, Dry, Cubic ft/min)=         6,844

                       * * METRIC UNITS * *
Barometric Pressure (mm Hg)=                       742
Static Pressure (mm H2O)=                           -4

Percent Oxygen=                                    7.8
Percent Carbon Dioxide=                           10.0
Moisture Collected (ml)=                        1871.3
Percent Water=                                    53.2

Average Delta P (mm H2O)=                         10.6
Average Stack Temperature (C)=                      83

Dry Molecular Weight=                            29.91
Wet Molecular Weight=                            23.58

Average Square Root of Delta P (mm H2O)=        3.2131
Pitot Coefficient=                                0.83
Stack Axis #1 (Meters)=                          0.904
Stack Axis #2 (Meters)=                          0.904
Circular Stack
Stack Area (Square Meters)=                      0.642

Stack Velocity  (Actual, m/min)=                   802
Flow rate (Actual, Cubic m/min)=                   515
  ow rate (Standard, Wet, Cubic m/min)=            414
  ow rate (Standard, Dry, Cubic m/min)=            194
```

```
FILE NAME - mobchr1                                        PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 1 (BACKGROUND)                  08-10-1988  10:14:59
LOCATION - Mobay Kansas City MO
DATE - 7/19/88
PROJECT # - 9101L3614

Point #         Delta P    Stack T
               (in. H2O)    (F)
 1              0.200      182
 2              0.150      183
 3              0.120      183
 4              0.060      183
 5              0.320      183
 6              0.410      183
 7              0.440      182
 8              0.440      183
 9              0.490      182
 10             0.430      182
 11             0.440      181
 12             0.430      181
 13             0.430      181
 14             0.370      181
 15             0.350      181
 16             0.470      180
 17             0.490      181
 18             0.430      181
 19             0.390      181
 20             0.400      181
 21             0.380      181
 22             0.370      181
 23             0.350      182
 24             0.340      181
 25             0.490      181
 26             0.460      181
 27             0.480      181
 28             0.510      181
 29             0.490      181
 30             0.490      181
 31             0.500      180
 32             0.510      180
 33             0.490      180
 34             0.490      180
 35             0.500      180
 36             0.500      180
 37             0.590      180
 38             0.510      180
 39             0.560      181
 40             0.470      181
 41             0.460      181
 42             0.480      180
 43             0.460      181
 44             0.420      180
 45             0.450      181
 46             0.380      181
 47             0.390      181
 48             0.220      180
```

```
FILE NAME - mobmet2                                                PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 2                                         08-10-1988  09:58:27
LOCATION - Mobay Kansas City MO
DATE - 7/20/88
PROJECT # - 9101L3614

 .itial Meter Volume (Cubic Feet)=             469.795
Final Meter Volume (Cubic Feet)=               550.316
Meter Factor=                                    1.018
Multiple leak checks, see end of printout              Leak Correction= -0.3096
Net Meter Volume (Cubic Feet)=                  81.639
Gas Volume (Dry Standard Cubic Feet)=           78.299

Barometric Pressure (in Hg)=                     29.35
Static Pressure (Inches H2O)=                    -0.15

Percent Oxygen=                                    4.2
Percent Carbon Dioxide=                           11.4
Moisture Collected (ml)=                        2430.9
Percent Water=                                    59.0  **Saturated Stack**

Average Meter Temperature (F)=                      81
Average Delta H (in H2O)=                         0.56
Average Delta P (in H2O)=                        0.559
Average Stack Temperature (F)=                     186

Dry Molecular Weight=                            29.99
Wet Molecular Weight=                            22.92

Average Square Root of Delta P (in H2O)=        0.7441
% Isokinetic=                                     99.3

Pitot Coefficient=                                0.83
Sampling Time (Minutes)=                         192.0
Nozzle Diameter (Inches)=                        0.271
Stack Axis #1 (Inches)=                           35.6
Stack Axis #2 (Inches)=                           35.6
Circular Stack
Stack Area (Square Feet)=                         6.91

Stack Velocity  (Actual, Feet/min)=              3,119
Flow Rate (Actual, Cubic ft/min)=               21,560
Flow rate (Standard, Wet, Cubic ft/min)=        17,289
Flow Rate (Standard, Dry, Cubic ft/min)=         7,088

Particulate Loading - Front Half

Particulate Weight (g)=                         0.1359     Corr. to 7% O2
Particulate Loading, Dry Std. (gr/scf)=         0.0267    0.0223
Particulate Loading, Actual (gr/cu ft)=         0.0088
Emission Rate (lb/hr)=                            1.62

No Back Half Analysis
```

```
                       * * METRIC UNITS * *
FILE NAME - mobmet2                                       PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 2                                08-10-1988  09:58:55
LOCATION - Mobay Kansas City MO
DATE - 7/20/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=           13.303
Final Meter Volume (Cubic Meters)=             15.583
Meter Factor=                                   1.018
Multiple leak checks, see end of printout                Leak Correction= -0.008
Net Meter Volume (Cubic Meters)=                2.312
Gas Volume (Dry Standard Cubic Meters)=         2.217

Barometric Pressure (mm Hg)=                      745
Static Pressure (mm H2O)=                          -4

Percent Oxygen=                                   4.2
Percent Carbon Dioxide=                          11.4
Moisture Collected (ml)=                       2430.9
Percent Water=                                   59.0    **Saturated Stack**

Average Meter Temperature (C)=                     27
Average Delta H (mm H2O)=                        14.1
Average Delta P (mm H2O)=                        14.2
Average Stack Temperature (C)=                     85

Dry Molecular Weight=                           29.99
Wet Molecular Weight=                           22.92

Average Square Root of Delta P (mm H2O)=       3.7502
  Isokinetic=                                    99.3

Pitot Coefficient=                               0.83
Sampling Time (Minutes)=                        192.0
Nozzle Diameter (mm)=                            6.88
Stack Axis #1 (Meters)=                         0.904
Stack Axis #2 (Meters)=                         0.904
Circular Stack
Stack Area (Square Meters)=                     0.642

Stack Velocity  (Actual, m/min)=                  951
Flow rate (Actual, Cubic m/min)=                  611
Flow rate (Standard, Wet, Cubic m/min)=           490
Flow rate (Standard, Dry, Cubic m/min)=           201

Particulate Loading - Front Half

Particulate Weight (g)=                           0.1        Corr. to 7% O2
Particulate Loading, Dry Std. (mg/cu m)=         61.3         51.1
Particulate Loading, Actual (mg/cu m)=           20.1
Emission Rate (kg/hr)=                           0.74

No Back Half Analysis
```

```
FILE NAME - mobmet2                                          PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 2                                   08-10-1988  09:59:22
LOCATION - Mobay Kansas City MO
DATE - 7/20/88
PROJECT # - 9101L3614

Point #       Delta P    Delta H    Stack T      Meter T
             (in. H2O)  (in. H2O)    (F)     In(F)  Out(F)
  1            0.300      0.34       183       74      74
  2            0.290      0.31       183       76      74
  3            0.470      0.44       186       78      75
  4            0.460      0.44       186       81      77
  5            0.530      0.51       186       82      78
  6            0.560      0.54       186       83      79
  7            0.580      0.57       186       83      79
  8            0.580      0.56       186       84      80
  9            0.590      0.57       186       83      81
  10           0.630      0.61       186       84      81
  11           0.660      0.65       186       83      82
  12           0.760      0.76       185       84      82
  13           0.600      0.62       185       85      83
  14           0.620      0.61       186       87      84
  15           0.630      0.62       186       84      83
  16           0.590      0.57       186       84      84
  17           0.590      0.60       185       84      83
  18           0.580      0.60       185       83      83
  19           0.580      0.61       185       83      83
  20           0.570      0.64       185       79      81
  21           0.590      0.57       186       81      81
  22           0.590      0.60       186       80      80
  23           0.600      0.60       186       79      80
  24           0.610      0.60       186       79      80
  25           0.440      0.42       186       77      77
  26           0.440      0.43       186       78      78
  27           0.530      0.51       186       78      78
  28           0.510      0.50       186       78      78
  29           0.550      0.53       186       78      78
  30           0.560      0.55       186       79      78
  31           0.580      0.57       186       79      78
  32           0.580      0.61       185       80      79
  33           0.580      0.58       186       80      79
  34           0.630      0.62       186       80      79
  35           0.600      0.62       185       80      79
  36           0.610      0.64       185       80      79
  37           0.680      0.67       186       80      79
  38           0.690      0.69       186       82      81
  39           0.680      0.68       186       83      80
  40           0.710      0.71       186       85      81
```

```
FILE NAME - mobmet2                                        PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 2                                 08-10-1988  09:59:50
LOCATION - Mobay Kansas City MO
DATE - 7/20/88
PROJECT # - 9101L3614

  1          0.690      0.69     186      84      82
 42          0.650      0.65     186      84      82
 43          0.500      0.48     186      86      83
 44          0.480      0.48     186      86      84
 45          0.480      0.45     186      83      84
 46          0.480      0.47     186      82      84
 47          0.320      0.32     185      75      75
 48          0.310      0.31     185      76      77


Fraction              Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                        (g)        (g)        (g)       (g)
DRY CATCH             0.0000     0.0000     0.0000    0.0000
FILTER                1.1212     1.0171     0.0004    0.1037

Fraction              Final Wt.  Tare Wt.    Vol.     Net Wt.
                        (g)        (g)       (ml)      (g)
PROBE RINSE         102.4633   102.4311    100.0    0.0322
IMPINGERS             0.0000     0.0000      0.0    0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.0200    96.0000
    0.0080    96.0000
```

```
FILE NAME - mobchr2                                      PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 2                             08-10-1988  10:15:35
LOCATION - Mobay Kansas City MO
DATE - 7/20/88
PROJECT # - 9101L3614


Barometric Pressure (in Hg)=                        29.35
Static Pressure (Inches H2O)=                       -0.15

Percent Oxygen=                                       4.2
Percent Carbon Dioxide=                              11.4
Moisture Collected (ml)=                           2596.0
Percent Water=                                       58.7   **Saturated Stack**

Average Delta P (in H2O)=                           0.530
Average Stack Temperature (F)=                        185

Dry Molecular Weight=                               29.99
Wet Molecular Weight=                               22.95

Average Square Root of Delta P (in H2O)=           0.7250
Pitot Coefficient=                                   0.84
Stack Axis #1 (Inches)=                              35.6
Stack Axis #2 (Inches)=                              35.6
Circular Stack
Stack Area (Square Feet)=                            6.91

Stack Velocity  (Actual, Feet/min)=                 3,044
Flow Rate (Actual, Cubic ft/min)=                  21,038
Flow rate (Standard, Wet, Cubic ft/min)=           16,876
   ow Rate (Standard, Dry, Cubic ft/min)=           6,968

                         * * METRIC UNITS * *
Barometric Pressure (mm Hg)=                          745
Static Pressure (mm H2O)=                              -4

Percent Oxygen=                                       4.2
Percent Carbon Dioxide=                              11.4
Moisture Collected (ml)=                           2596.0
Percent Water=                                       58.7   **Saturated Stack**

Average Delta P (mm H2O)=                            13.5
Average Stack Temperature (C)=                         85

Dry Molecular Weight=                               29.99
Wet Molecular Weight=                               22.95

Average Square Root of Delta P (mm H2O)=           3.6540
Pitot Coefficient=                                   0.84
Stack Axis #1 (Meters)=                             0.904
Stack Axis #2 (Meters)=                             0.904
Circular Stack
Stack Area (Square Meters)=                         0.642

Stack Velocity  (Actual, m/min)=                      928
Flow rate (Actual, Cubic m/min)=                      596
  ow rate (Standard, Wet, Cubic m/min)=               478
Flow rate (Standard, Dry, Cubic m/min)=               197
```

```
FILE NAME - mobchr2                                      PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 2                             08-10-1988  10:16:04
LOCATION - Mobay Kansas City MO
DATE - 7/20/88
PROJECT # - 9101L3614

Point #     Delta P    Stack T
           (in. H20)    (F)
 1          0.470      185
 2          0.470      185
 3          0.500      186
 4          0.540      187
 5          0.490      186
 6          0.500      186
 7          0.490      186
 8          0.550      187
 9          0.600      186
 10         0.600      186
 11         0.550      185
 12         0.620      185
 13         0.580      185
 14         0.650      185
 15         0.630      186
 16         0.490      185
 17         0.510      185
 18         0.530      185
 19         0.490      186
 20         0.470      186
 21         0.360      185
 22         0.370      186
 23         0.360      186
 24         0.310      186
 25         0.570      186
 26         0.550      186
 27         0.540      185
 28         0.580      186
 29         0.580      185
 30         0.620      185
 31         0.620      185
 32         0.590      185
 33         0.590      185
 34         0.590      185
 35         0.580      185
 36         0.630      186
 37         0.610      185
 38         0.610      185
 39         0.600      185
 40         0.580      185
 41         0.620      186
 42         0.600      185
 43         0.530      186
 44         0.540      185
 45         0.430      185
 46         0.400      184
 47         0.400      185
 48         0.330      184
```

```
FILE NAME - mobmet3                                          PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 3                                   08-10-1988  10:02:55
LOCATION - Mobay Kansas City MO
DATE - 7/21/87
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=             552.138
Final Meter Volume (Cubic Feet)=               632.602
Meter Factor=                                    1.018
Multiple leak checks, see end of printout                 Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                  81.896
Gas Volume (Dry Standard Cubic Feet)=           77.126

Barometric Pressure (in Hg)=                     29.42
Static Pressure (Inches H2O)=                    -0.15

Percent Oxygen=                                    5.8
Percent Carbon Dioxide=                           11.0
Moisture Collected (ml)=                        2186.4
Percent Water=                                    55.6  **Saturated Stack**

Average Meter Temperature (F)=                      92
Average Delta H (in H2O)=                         0.55
Average Delta P (in H2O)=                        0.468
Average Stack Temperature (F)=                     183

Dry Molecular Weight=                            29.99
Wet Molecular Weight=                            23.32

Average Square Root of Delta P (in H2O)=        0.6794
% Isokinetic=                                     99.5

Pitot Coefficient=                                0.83
Sampling Time (Minutes)=                         192.0
Nozzle Diameter (Inches)=                        0.271
Stack Axis #1 (Inches)=                           35.6
Stack Axis #2 (Inches)=                           35.6
Circular Stack
Stack Area (Square Feet)=                         6.91

Stack Velocity  (Actual, Feet/min)=              2,814
Flow Rate (Actual, Cubic ft/min)=               19,451
Flow rate (Standard, Wet, Cubic ft/min)=        15,698
Flow Rate (Standard, Dry, Cubic ft/min)=         6,964

Particulate Loading - Front Half

Particulate Weight (g)=                         0.1084       Corr. to 7% O2
Particulate Loading, Dry Std. (gr/scf)=         0.0216      0.0199
Particulate Loading, Actual (gr/cu ft)=         0.0077
Emission Rate (lb/hr)=                            1.29

No Back Half Analysis
```

```
                         * * METRIC UNITS * *
FILE NAME - mobmet3                                     PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 3                              08-10-1988  10:03:23
LOCATION - Mobay Kansas City MO
DATE - 7/21/87
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=          15.634
Final Meter Volume (Cubic Meters)=            17.913
Meter Factor=                                  1.018
Multiple leak checks, see end of printout              Leak Correction=  0.000
Net Meter Volume (Cubic Meters)=               2.319
Gas Volume (Dry Standard Cubic Meters)=        2.184

Barometric Pressure (mm Hg)=                     747
Static Pressure (mm H20)=                         -4

Percent Oxygen=                                  5.8
Percent Carbon Dioxide=                         11.0
Moisture Collected (ml)=                      2186.4
Percent Water=                                  55.6   **Saturated Stack**

Average Meter Temperature (C)=                    33
Average Delta H (mm H20)=                       13.9
Average Delta P (mm H20)=                       11.9
Average Stack Temperature (C)=                    84

Dry Molecular Weight=                          29.99
Wet Molecular Weight=                          23.32

Average Square Root of Delta P (mm H20)=      3.4240
  Isokinetic=                                   99.5

Pitot Coefficient=                              0.83
Sampling Time (Minutes)=                       192.0
Nozzle Diameter (mm)=                           6.88
Stack Axis #1 (Meters)=                        0.904
Stack Axis #2 (Meters)=                        0.904
Circular Stack
Stack Area (Square Meters)=                    0.642

Stack Velocity  (Actual, m/min)=                 858
Flow rate (Actual, Cubic m/min)=                 551
Flow rate (Standard, Wet, Cubic m/min)=          445
Flow rate (Standard, Dry, Cubic m/min)=          197

Particulate Loading - Front Half

Particulate Weight (g)=                          0.1      Corr. to 7% O2
Particulate Loading, Dry Std. (mg/cu m)=        49.6       45.7
Particulate Loading, Actual (mg/cu m)=          17.8
Emission Rate (kg/hr)=                          0.59

No Back Half Analysis
```

```
FILE NAME - mobmet3                                   PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 3                            08-10-1988  10:03:50
LOCATION - Mobay Kansas City MO
DATE - 7/21/87
PROJECT # - 9101L3614

  int #      Delta P    Delta H    Stack T     Meter T
            (in. H2O)  (in. H2O)     (F)     In(F)  Out(F)
  1           0.210      0.26        182       86      86
  2           0.220      0.27        182       87      87
  3           0.340      0.36        184       87      87
  4           0.320      0.37        183       88      88
  5           0.380      0.45        183       90      88
  6           0.390      0.45        184       91      89
  7           0.440      0.47        184       91      90
  8           0.430      0.47        184       93      91
  9           0.540      0.61        184       94      92
  10          0.510      0.61        184       95      93
  11          0.500      0.61        184       96      94
  12          0.510      0.56        184       95      94
  13          0.540      0.60        184       95      94
  14          0.550      0.62        184       96      95
  15          0.580      0.66        184       97      96
  16          0.550      0.62        184       95      95
  17          0.510      0.59        183       92      94
  18          0.490      0.54        184       93      94
  19          0.400      0.43        184       94      94
  20          0.430      0.49        183       93      93
  21          0.450      0.51        183       94      93
  22          0.450      0.51        183       92      92
  23          0.430      0.50        183       91      92
  24          0.410      0.47        183       92      92
  25          0.230      0.32        179       83      82
  26          0.270      0.37        178       85      84
  27          0.390      0.50        181       87      84
  28          0.350      0.35        180       88      85
  29          0.430      0.60        181       87      85
  30          0.430      0.62        181       88      86
  31          0.470      0.55        183       91      87
  32          0.520      0.63        183       92      88
  33          0.520      0.66        183       94      89
  34          0.530      0.67        183       95      90
  35          0.590      0.70        183       97      92
  36          0.550      0.68        183       92      92
  37          0.570      0.66        184       91      91
  38          0.550      0.65        183       93      91
  39          0.530      0.63        183       94      92
  40          0.530      0.61        184       97      93
```

```
FILE NAME - mobmet3                                          PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 3                                   08-10-1988  10:04:19
LOCATION - Mobay Kansas City MO
DATE - 7/21/87
PROJECT # - 9101L3614

  1         0.550      0.60      184      97      94
 42         0.560      0.64      184      96      94
 43         0.540      0.70      183      97      94
 44         0.540      0.62      184      97      94
 45         0.550      0.62      184      97      95
 46         0.560      0.63      184      96      95
 47         0.540      0.63      184      96      95
 48         0.570      0.67      184      97      96


Fraction                 Final Wt. Tare Wt. Blank Wt. Net Wt.
                            (g)       (g)      (g)      (g)
DRY CATCH                0.0000    0.0000   0.0000   0.0000
FILTER                   1.0997    1.0108   0.0004   0.0885

Fraction                 Final Wt. Tare Wt.   Vol.    Net Wt.
                            (g)       (g)     (ml)      (g)
PROBE RINSE            103.6071  103.5872   100.0   0.0199
IMPINGERS                0.0000    0.0000     0.0   0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.0100    96.0000
    0.0090    96.0000
```

```
FILE NAME - mobchr3                                         PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 3                                08-10-1988  10:16:44
LOCATION - Mobay Kansas City MO
DATE - 7/21/88
PROJECT # - 9101L3614


Barometric Pressure (in Hg)=                      29.42
Static Pressure (Inches H2O)=                     -0.15

Percent Oxygen=                                     5.8
Percent Carbon Dioxide=                            11.0
Moisture Collected (ml)=                         2371.8
Percent Water=                                     56.5  **Saturated Stack**

Average Delta P (in H2O)=                         0.504
Average Stack Temperature (F)=                      184

Dry Molecular Weight=                             29.99
Wet Molecular Weight=                             23.22

Average Square Root of Delta P (in H2O)=         0.7062
Pitot Coefficient=                                 0.84
Stack Axis #1 (Inches)=                            35.6
Stack Axis #2 (Inches)=                            35.6
Circular Stack
Stack Area (Square Feet)=                          6.91

Stack Velocity  (Actual, Feet/min)=               2,940
Flow Rate (Actual, Cubic ft/min)=                20,325
Flow rate (Standard, Wet, Cubic ft/min)=         16,386
   ow Rate (Standard, Dry, Cubic ft/min)=         7,127

                        * * METRIC UNITS * *
Barometric Pressure (mm Hg)=                        747
Static Pressure (mm H2O)=                             -4

Percent Oxygen=                                     5.8
Percent Carbon Dioxide=                            11.0
Moisture Collected (ml)=                         2371.8
Percent Water=                                     56.5  **Saturated Stack**

Average Delta P (mm H2O)=                          12.8
Average Stack Temperature (C)=                       84

Dry Molecular Weight=                             29.99
Wet Molecular Weight=                             23.22

Average Square Root of Delta P (mm H2O)=         3.5594
Pitot Coefficient=                                 0.84
Stack Axis #1 (Meters)=                           0.904
Stack Axis #2 (Meters)=                           0.904
Circular Stack
Stack Area (Square Meters)=                       0.642

Stack Velocity  (Actual, m/min)=                    896
Flow rate (Actual, Cubic m/min)=                    576
  ow rate (Standard, Wet, Cubic m/min)=             464
Flow rate (Standard, Dry, Cubic m/min)=             202
```

```
FILE NAME - mobchr3                              PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 3                     08-10-1988  10:17:13
LOCATION - Mobay Kansas City MO
DATE - 7/21/88
PROJECT # - 9101L3614

Point #        Delta P    Stack T
              (in. H2O)     (F)
  1            0.340      179
  2            0.340      181
  3            0.360      181
  4            0.370      181
  5            0.350      181
  6            0.420      181
  7            0.400      183
  8            0.490      185
  9            0.500      185
  10           0.530      184
  11           0.600      184
  12           0.620      184
  13           0.670      183
  14           0.580      184
  15           0.590      184
  16           0.550      185
  17           0.580      184
  18           0.640      185
  19           0.670      185
  20           0.600      185
  21           0.600      185
  22           0.460      185
  23           0.450      185
  24           0.430      186
  25           0.480      185
  26           0.530      184
  27           0.510      184
  28           0.540      184
  29           0.580      185
  30           0.550      184
  31           0.570      185
  32           0.580      184
  33           0.580      185
  34           0.510      184
  35           0.530      184
  36           0.550      184
  37           0.530      184
  38           0.520      185
  39           0.600      185
  40           0.550      184
  41           0.550      184
  42           0.530      185
  43           0.540      184
  44           0.440      183
  45           0.370      183
  46           0.380      182
  47           0.270      183
  48           0.270      182
```

```
FILE NAME - mobmet4                                            PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 4                                     08-10-1988  10:07:14
LOCATION - Mobay Kansas City MO
DATE - 7/22/88
PROJECT # - 9101L3614

  itial Meter Volume (Cubic Feet)=                 634.316
Final Meter Volume (Cubic Feet)=                   715.972
Meter Factor=                                        1.018
Multiple leak checks, see end of printout                     Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                      83.109
Gas Volume (Dry Standard Cubic Feet)=               77.810

Barometric Pressure (in Hg)=                        29.38
Static Pressure (Inches H2O)=                       -0.15

Percent Oxygen=                                       5.2
Percent Carbon Dioxide=                              11.4
Moisture Collected (ml)=                           2579.8
Percent Water=                                       59.6  **Saturated Stack**

Average Meter Temperature (F)=                         94
Average Delta H (in H2O)=                            0.56
Average Delta P (in H2O)=                           0.559
Average Stack Temperature (F)=                        186

Dry Molecular Weight=                               30.03
Wet Molecular Weight=                               22.86

Average Square Root of Delta P (in H2O)=           0.7435
% Isokinetic=                                       100.1

Pitot Coefficient=                                   0.83
Sampling Time (Minutes)=                            192.0
Nozzle Diameter (Inches)=                           0.271
Stack Axis #1 (Inches)=                              35.6
Stack Axis #2 (Inches)=                              35.6
Circular Stack
Stack Area (Square Feet)=                            6.91

Stack Velocity  (Actual, Feet/min)=                 3,120
Flow Rate (Actual, Cubic ft/min)=                  21,568
Flow rate (Standard, Wet, Cubic ft/min)=           17,299
Flow Rate (Standard, Dry, Cubic ft/min)=            6,986

Particulate Loading - Front Half

Particulate Weight (g)=                            0.1206      Corr. to 7% O2
Particulate Loading, Dry Std. (gr/scf)=            0.0239     0.0212
Particulate Loading, Actual (gr/cu ft)=            0.0077
Emission Rate (lb/hr)=                               1.43

No Back Half Analysis
```

```
                          * * METRIC UNITS * *
FILE NAME - mobmet4                                         PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 4                                  08-10-1988  10:07:42
LOCATION - Mobay Kansas City MO
DATE - 7/22/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=           17.961
Final Meter Volume (Cubic Meters)=             20.273
Meter Factor=                                   1.018
Multiple leak checks, see end of printout               Leak Correction=  0.000
Net Meter Volume (Cubic Meters)=                2.353
Gas Volume (Dry Standard Cubic Meters)=         2.203

Barometric Pressure (mm Hg)=                      746
Static Pressure (mm H20)=                          -4

Percent Oxygen=                                   5.2
Percent Carbon Dioxide=                          11.4
Moisture Collected (ml)=                       2579.8
Percent Water=                                   59.6   **Saturated Stack**

Average Meter Temperature (C)=                     35
Average Delta H (mm H20)=                        14.3
Average Delta P (mm H20)=                        14.2
Average Stack Temperature (C)=                     86

Dry Molecular Weight=                           30.03
Wet Molecular Weight=                           22.86

Average Square Root of Delta P (mm H20)=       3.7473
  Isokinetic=                                   100.1

Pitot Coefficient=                               0.83
Sampling Time (Minutes)=                        192.0
Nozzle Diameter (mm)=                            6.88
Stack Axis #1 (Meters)=                         0.904
Stack Axis #2 (Meters)=                         0.904
Circular Stack
Stack Area (Square Meters)=                     0.642

Stack Velocity  (Actual, m/min)=                  951
Flow rate (Actual, Cubic m/min)=                  611
Flow rate (Standard, Wet, Cubic m/min)=           490
Flow rate (Standard, Dry, Cubic m/min)=           198

Particulate Loading - Front Half

Particulate Weight (g)=                           0.1       Corr. to 7% O2
Particulate Loading, Dry Std. (mg/cu m)=         54.7        48.3
Particulate Loading, Actual (mg/cu m)=           17.7
Emission Rate (kg/hr)=                           0.65

No Back Half Analysis
```

```
FILE NAME - mobmet4                                    PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 4                             08-10-1988  10:08:10
LOCATION - Mobay Kansas City MO
DATE - 7/22/88
PROJECT # - 9101L3614

. int #      Delta P    Delta H    Stack T      Meter T
           (in. H2O)  (in. H2O)     (F)     In(F)   Out(F)
 1            0.330      0.37       184       82       82
 2            0.330      0.35       185       84       82
 3            0.460      0.48       185       85       83
 4            0.460      0.48       185       88       84
 5            0.500      0.53       185       91       85
 6            0.490      0.50       186       93       87
 7            0.550      0.56       186       94       89
 8            0.550      0.56       186       94       89
 9            0.590      0.60       186       95       90
 10           0.640      0.66       186       95       92
 11           0.710      0.73       186       94       92
 12           0.680      0.70       186       93       92
 13           0.640      0.66       186       95       93
 14           0.640      0.66       186       97       93
 15           0.650      0.67       186       98       94
 16           0.610      0.63       186       99       98
 17           0.600      0.63       186      102       98
 18           0.650      0.64       187      101       99
 19           0.610      0.60       187      100       99
 20           0.610      0.60       187      101       99
 21           0.610      0.60       187       99       99
 22           0.610      0.63       186      100       99
 23           0.560      0.55       187      102       99
  4           0.580      0.57       187      102       99
 25           0.310      0.30       187       91       92
 26           0.300      0.29       186       88       93
 27           0.440      0.44       186       88       92
 28           0.460      0.44       187       89       92
 29           0.520      0.50       187       90       92
 30           0.540      0.51       187       93       93
 31           0.530      0.45       189       93       93
 32           0.580      0.54       187       94       93
 33           0.610      0.60       186       96       94
 34           0.610      0.59       186       98       94
 35           0.640      0.64       186      101       96
 36           0.620      0.63       186      102       96
 37           0.680      0.71       186      102       98
 38           0.690      0.72       186      102       98
 39           0.770      0.80       186      100       98
 40           0.720      0.75       186       97       97
```

```
FILE NAME - mobmet4                                         PROG.=VER 03/04/87 V1
RUN # - MOBAY METALS RUN 4                                  08-10-1988  10:03:38
LOCATION - Mobay Kansas City MO
DATE - 7/22/88
PROJECT # - 9101L3614

  1          0.750      0.75      186       96       97
 42          0.690      0.72      186       96       96
 43          0.510      0.53      186       96       96
 44          0.470      0.47      186       95       95
 45          0.420      0.42      186       94       96
 46          0.460      0.46      186       93       95
 47          0.420      0.41      186       93       95
 48          0.440      0.43      186       94       95


Fraction                Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                           (g)        (g)       (g)       (g)
DRY CATCH               0.0000     0.0000     0.0000    0.0000
FILTER                  1.1266     1.0266     0.0004    0.0996

Fraction                Final Wt.  Tare Wt.    Vol.     Net Wt.
                           (g)        (g)      (ml)       (g)
PROBE RINSE            92.9512    92.9302    100.0     0.0210
IMPINGERS               0.0000     0.0000      0.0     0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed belo

Lk Rate (cfm) Time (min)
    0.0060    96.0000
    0.0090    96.0000
```

```
FILE NAME - mobchr4                                          PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 4                                 08-10-1988  10:17:48
LOCATION - Mobay Kansas City MO
DATE - 7/22/88
PROJECT # - 9101L3614


Barometric Pressure (in Hg)=                       29.38
Static Pressure (Inches H2O)=                      -0.15

Percent Oxygen=                                      5.2
Percent Carbon Dioxide=                             11.4
Moisture Collected (ml)=                          2512.8
Percent Water=                                      59.6  **Saturated Stack**

Average Delta P (in H2O)=                          0.554
Average Stack Temperature (F)=                       186

Dry Molecular Weight=                              30.03
Wet Molecular Weight=                              22.87

Average Square Root of Delta P (in H2O)=          0.7404
Pitot Coefficient=                                  0.84
Stack Axis #1 (Inches)=                             35.6
Stack Axis #2 (Inches)=                             35.6
Circular Stack
Stack Area (Square Feet)=                           6.91

Stack Velocity  (Actual, Feet/min)=                3,114
Flow Rate (Actual, Cubic ft/min)=                 21,524
Flow rate (Standard, Wet, Cubic ft/min)=          17,265
   ow Rate (Standard, Dry, Cubic ft/min)=          6,982

                        * * METRIC UNITS * *
Barometric Pressure (mm Hg)=                         746
Static Pressure (mm H2O)=                             -4

Percent Oxygen=                                      5.2
Percent Carbon Dioxide=                             11.4
Moisture Collected (ml)=                          2512.8
Percent Water=                                      59.6  **Saturated Stack**

Average Delta P (mm H2O)=                           14.1
Average Stack Temperature (C)=                        86

Dry Molecular Weight=                              30.03
Wet Molecular Weight=                              22.87

Average Square Root of Delta P (mm H2O)=          3.7314
Pitot Coefficient=                                  0.84
Stack Axis #1 (Meters)=                            0.904
Stack Axis #2 (Meters)=                            0.904
Circular Stack
Stack Area (Square Meters)=                        0.642

Stack Velocity  (Actual, m/min)=                     949
  ow rate (Actual, Cubic m/min)=                     610
  ow rate (Standard, Wet, Cubic m/min)=              489
Flow rate (Standard, Dry, Cubic m/min)=              198
```

```
FILE NAME - mobchr4                                              PROG.=VER 03/04/87 V1
RUN # - MOBAY CHROMIUM RUN 4                                     08-10-1988  10:18:18
LOCATION - Mobay Kansas City MO
DATE - 7/22/88
PROJECT # - 9101L3614

 int #          Delta P    Stack T
               (in. H2O)    (F)
 1              0.400      187
 2              0.440      188
 3              0.440      187
 4              0.470      187
 5              0.480      186
 6              0.510      186
 7              0.510      186
 8              0.540      185
 9              0.540      185
 10             0.720      186
 11             0.740      186
 12             0.760      186
 13             0.760      186
 14             0.680      187
 15             0.640      186
 16             0.610      186
 17             0.590      187
 18             0.570      186
 19             0.560      187
 20             0.510      187
 21             0.420      186
 22             0.440      187
 23             0.340      187
  4             0.330      187
 25             0.630      186
 26             0.630      187
 27             0.640      186
 28             0.610      186
 29             0.650      186
 30             0.660      186
 31             0.630      186
 32             0.630      186
 33             0.640      186
 34             0.630      186
 35             0.650      187
 36             0.620      185
 37             0.590      185
 38             0.640      186
 39             0.600      186
 40             0.590      186
 41             0.520      186
 42             0.580      186
 43             0.510      187
 44             0.510      186
 45             0.370      185
 46             0.370      183
 47             0.390      185
 48             0.320      186
```

APPENDIX B-4

ORGANIC ANALYSIS DATA

Table B-4-1. Organic Analysis Summary
Table B-4-2. Organic Compound Boiling Point Ranges
Table B-4-3. Volatile Organics Data for C_1-C_2 Hydrocarbons
Table B-4-4. Volatile Organics Data for C_3-C_7 Hydrocarbons
Table B-4-5. Condensate Analysis for C_1-C_7 Hydrocarbons
Table B-4-6. Semivolatile Organics Data (C_1-C_7 Hydrocarbons)
Table B-4-7. Nonvolatile Organic Analysis Data
Table B-4-8. Nonvolatile Organic Analysis Summary
Table B-4-9. MM5 Data Summary
Table B-4-10. Method 3 (Orsat) Results
Table B-4-11. MM5 Raw Data

TABLE B-4-1. ORGANIC ANALYSIS SUMMARY

Run	CO (ppm)	CO at 7% O_2 (ppm)	THC, hot (ppm)	THC, cold (ppm)	Volatile fractions C_1-C_2 (ppm)	C_3-C_7 (ppm)	Condensate (ppm)	Total volatiles (ppm)	Nonvolatiles (ppm)	Semivolatiles (ppm)	Total organics (ppm)
8S	196	168	51.2	6.7	1.1	5.5	11.0	17.6	-	-	-
5	125	111	36	3.6	0	3.7	2.3	6	1.6	1.5	9.1
6	511	460	88	12	0	1.0	13.8	14.6	3.4	1.4	19.6
7	1,099	1,068	207	7.6	1.3	8.8	19.0	29.1	2.0	29.1	60.2
8	2,460	2,464	227	60.5	34.1	22.0	70.3	126.4	2.1	5.9	134.4
9	3,705	2,762	199	61.4	9.1	1.4	6.6	17.1	1.5	6.0	24.6
10	2,458	2,128	86	18	7.3	6.0	30.8	44.1	1.3	1.0	46.4

TABLE B-4-2. ORGANIC COMPOUND BOILING POINT RANGES[a]

Boiling point range (°C)	Carbon No.	Specific hydrocarbon	Boiling point (°C)
Volatiles			
-160 to -100	C_1	Methane	-161
-100 to -50	C_2	Ethane	-88
-50 to 0	C_3	Propane	-42
0 to 30	C_4	Butane	0
30 to 60	C_5	Pentane	36
60 to 90	C_6	Hexane	69
90 to 100	C_7	Heptane	96
Semivolatiles			
100 to 300	C_7-C_{17}	-	-
Nonvolatiles			
> 300	> C_{17}	-	-

[a] *IERL-RTP Procedure Manual: Level 1 Environmental Assessment*, 2nd Ed., U.S. Environmental Protection Agency, EPA-600/7-78-201, October 1978.

TABLE B-4-3. VOLATILE ORGANICS DATA FOR C_1-C_2 HYDROCARBONS

	Average areas from duplicate injections													
	Run 5		Run 6		Run 7		Run 8		Run 8S		Run 9		Run 10	
Time	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank
60	2,573	2,229	20,213	20,196	28,422	28,240	157,822	28,478	29,287	32,538	58,897	25,037	50,551	11,666
68	343													
83														24
92							7768				780		1,236	723
102			48		590		5,283		95		4,774		6,732	649
111	376	333	1,304	1,444	1,894	2,091	1,742	1,826	1,879	1,878	1,859	1,764	1,410	1,224
C_1-C_2 total sample area	3,292	2,562	21,564	21,640	30,906	30,331	172,615	30,304	31,262	34,416	66,309	26,801	59,928	14,285
Avg. RF for propane from daily stds.	4,122	4,122	3,885	3,885	4,136	4,136	4,284	4,284	4,284	4,284	4,351	4,351	4,440	4,440
Total conc. as ppm propane	0.80	0.62	5.55	5.57	7.47	7.33	40.29	7.07	7.30	8.03	15.24	6.16	13.50	3.22
Methane as ppm propane	0.71	0.54	5.20	5.20	6.87	6.83	36.84	6.65	6.84	7.60	13.54	5.75	11.39	2.63
Acetylene as ppm propane	0.00	0.00	0.00	0.00	0.00	0.00	1.81	0.00	0.00	0.00	0.18	0.00	0.28	0.16
Ethylene as ppm propane	0.00	0.00	0.01	0.00	0.14	0.00	1.23	0.00	0.02	0.00	1.10	0.00	1.52	0.15
Ethane as ppm propane	0.09	0.08	0.34	0.37	0.46	0.51	0.41	0.43	0.44	0.44	0.43	0.41	0.32	0.28
Methane as ppm methane	2.29	1.75	16.88	16.86	22.29	22.15	119.50	21.56	22.18	24.64	43.91	18.67	36.93	8.52
Acetylene as ppm acetylene	0.00	0.00	0.00	0.00	0.00	0.00	2.57	0.00	0.00	0.00	0.25	0.00	0.40	0.23
Ethylene as ppm ethylene	0.00	0.00	0.02	0.00	0.26	0.00	2.22	0.00	0.04	0.00	1.97	0.00	2.73	0.26
Ethane as ppm ethane	0.13	0.12	0.49	0.54	0.67	0.73	0.59	0.62	0.64	0.64	0.62	0.59	0.46	0.40

TABLE B-4-4. VOLATILE ORGANICS DATA FOR C_3-C_7 HYDROCARBONS

	Average areas of replicate injections													
	Run 5		Run 6		Run 7		Run 8		Run 8S		Run 9		Run 10	
Time	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank	Sample	Blank
25	26,818		5,728		71,720		110,667		47,819		10,821		49,332	
30		269	1,422	417		503	17,343	819		966	2,125	1,730		13,314
33		290		316		327								
35							27,328							
40	584	135	319	238	1,327	222		287		156	65	158		336
44							4,985							
47	1,603	212		328		315		353		307		255		983
55	1,185	80	359	93	1,433	100	1,260	118		81		31		
61							2,947	195		348		665	181	1,002
68	1,156		520		3,474		9,408				524		5,897	234
83	486	116	522	507	439	605	1,094	450		296		158		116
90	103	15	13	18		6	794	42						93
98							419							
112	61	53	232	45	322		842	83		73				
122										12				
162						35								
165			49	69		60								
169							4,756	68		59	1,076	18		
181								77						
198			380	489	829	868								472
204	171						737	561		512		305		
248			416											
252							967							
C_3-C_7 total sample area	32,167	1,169	9,960	2,519	79,544	3,039	183,547	3,053	47,819	2,809	14,611	3,320	55,410	16,550
Avg. propane RF of daily stds	7,880	7,880	7,335	7,335	8,673	8,673	8,229	8,229	8,229	8,229	8,377	8,377	8,703	8,703
Conc. (ppm)	4.08	0.15	1.36	0.34	9.17	0.35	22.30	0.37	5.81	0.34	1.74	0.40	6.37	1.90

TABLE B-4-5. CONDENSATE ANALYSIS, C_1-C_7 HYDROCARBONS

	Average areas from replicate injections							
Time	Run 5	Time[a]	Run 6	Run 7	Run 8	Run 8S	Run 9	Run 10
105	676	51	34,333	24,004	25,504	25,947	23,401	33,677
295	64	63		24,087	13,419	4,297	31,092	49,543
317	5,493	69			235,370	12,785		
1185	90	88		8,236				
1275	140	90						4,396
		104		287				
		145		673				
		165			4,360		463	332
		192		1,438				
		202		849				
		215		690	1,515			
		223		367				
		246		164				
		273			180			
		345				100		
		385	208					
		397		107				
		405		69				
		409		60				
		426		54				
		429		36				
		504		47				
		563		185				
C_1-C_7 total sample area	6,463		34,541	61,353	280,348	43,129	54,956	87,948
Avg. propane RF from daily stds.	4,300		4,367	4,424	4,346	4,346	4,446	4,335

(continued)

TABLE B-4-5 (continued)

	Average areas from replicate injections							
Time	Run 5	Time[a]	Run 6	Run 7	Run 8	Run 8S	Run 9	Run 10
Conc. (ppm)	1.50		7.91	13.87	64.51	9.92	12.36	20.29
Ratio of condensate to vapor volume	1.5		1.75	1.37	1.09	1.11	0.53	1.52
Total conc. (ppm)	2.25		13.84	19.00	70.31	11.02	6.55	30.84

[a] Runs 6 through 10 used a shorter temperature program than Run 5.

TABLE B-4-6. SEMIVOLATILE ORGANICS DATA
(C_7-C_{17} Hydrocarbons)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc.* ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
Run 5 train													
A - $MeCl_2$	96,719	46,401	6,944	53,424	126,320	24.4	11.7	1.8	13.5				
B - $MeCl_2$	99,304	38,096	8,104	50,992	126,320	25.1	9.6	2.0	12.9				
Avg. - $MeCl_2$						24.8	10.7	1.9	13.2	505.0	2,387	0.1	0.0
A - Ether	50,575	15,168	3,872	17,968	134,160	12.0	3.6	0.9	4.3				
B - Ether	50,106	18,448	2,688	15,904	134,160	11.9	4.4	0.6	3.8				
Avg. - Ether						12.0	4.0	0.8	4.0	207.7	2,387	-0.1	0.0
A - Toluene	435,936	258,464	0	11,648	132,664	119.8	71.0	0.0	3.2				
B - Toluene	550,690	230,464	0	21,280	132,664	151.3	63.3	0.0	5.8				
Avg. - Toluene						135.6	67.2	0.0	4.5	2,072.7	2,387	0.1	0.1
Total train						172.3	81.8	2.7	21.7	2,785.5	2,387	0.2	0.1
Run 5 condensate													
A - $MeCl_2$	25,792	23,792	4,768	51,936	127,976	7.3	6.8	1.4	14.8				
B - $MeCl_2$	25,856	25,024	2,304	22,480	127,976	7.4	7.1	0.7	6.4				
Avg. - $MeCl_2$						7.4	7.0	1.0	10.6	772.3	2,387	0.2	0.1
A - Ether	30,098	239,870	2,624	23,104	126,320	7.6	60.6	0.7	5.8				
B - Ether	35,750	279,627	3,360	30,624	126,320	9.0	70.6	0.8	7.7				
Avg. - Ether						8.3	65.6	0.8	6.8	2,427.2	2,387	0.8	0.5
A - Toluene	453,671	63,600	2,040	32,200	121,636	136.0	19.1	0.6	9.7				
B - Toluene	211,022	62,080	3,104	45,056	121,636	63.2	18.6	0.9	13.5				
Avg. - Toluene						99.6	18.8	0.8	11.6	3,897.7	2,387	1.4	0.8
Total condensate						115.3	91.4	2.5	29.0	7,097.2	2,387	2.4	1.4
Run 5 total						287.6	173.2	5.2	50.7	9,882.7	2,387	2.6	1.5
Run 6 train													
A - $MeCl_2$	78,344	47,096	4,432	32,168	131,088	19.1	11.5	1.1	7.8				
B - $MeCl_2$	79,056	45,464	3,752	41,448	131,088	19.2	11.1	0.9	10.1				
Avg. - $MeCl_2$						19.2	11.3	1.0	9.0	403.7	1,883	0.0	0.0
A - Ether	92,680	22,466	3,824	19,120	134,160	22.0	5.3	0.9	4.5				
B - Ether	74,029	20,192	3,520	21,600	134,160	17.6	4.8	0.8	5.1				
Avg. - Ether						19.8	5.1	0.9	4.8	306.1	1,883	0.0	0.0

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Toluene	574,720	235,136	0	34,496	132,664	157.9	64.6	0.0	9.5				
B - Toluene	482,432	288,736	832	35,392	132,664	132.6	79.3	0.2	9.7				
Avg. - Toluene						145.3	72.0	0.2	9.6	2,270.7	1,883	0.3	0.2
Total train						184.2	88.3	2.1	23.4	2,980.4	1,883	0.3	0.2
Run 6 condensate													
A - $MeCl_2$	29,984	35,440	5,504	49,504	127,976	8.5	10.1	1.6	14.1				
B - $MeCl_2$	30,528	30,016	0	12,320	127,976	7.6	7.5	0.0	3.1				
Avg. - $MeCl_2$						8.1	8.8	1.6	8.6	799.8	1,883	0.3	0.2
A - Ether	34,935	141,126	2,720	14,400	126,320	8.8	35.6	0.7	3.6				
B - Ether	34,871	150,550	2,832	18,016	126,320	8.8	38.0	0.7	4.5				
Avg. - Ether						8.8	36.8	0.7	4.1	1,492.9	1,883	0.5	0.3
A - Toluene	103,053	30,451	1,920	18,288	121,636	30.9	9.1	0.6	5.5				
B - Toluene	484,382	33,712	0	18,664	121,636	145.2	10.1	0.0	5.7				
Avg. - Toluene						88.0	9.6	0.6	5.6	3,072.3	1,883	1.3	0.7
Total condensate						104.9	55.2	2.8	18.2	5,365.0	1,883	2.1	1.2
Run 6 total						289.2	143.5	4.9	41.6	8,345.4	1,883	2.4	1.4
Run 7 train													
A - $MeCl_2$	91,792	15,888	5,464	38,176	131,088	22.3	3.9	1.3	9.3				
B - $MeCl_2$	91,256	16,488	5,624	36,664	131,088	22.2	4.0	1.4	8.9				
Avg. - $MeCl_2$						22.3	3.9	1.3	9.1	366.7	2,420	0.0	0.0
A - Ether	63,820	11,568	3,344	17,264	134,160	15.2	2.8	0.8	4.1				
B - Ether	56,579	7,024	2,464	15,840	134,160	13.5	1.7	0.6	3.8				
Avg. - Ether						14.3	2.2	0.7	3.9	211.5	2,420	0.0	0.0

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Toluene	322,688	209,216	0	15,360	132,664	88.7	57.5	0.0	4.2				
B - Toluene	336,392	223,128	0	11,776	132,664	92.4	61.3	0.0	3.2				
Avg. - Toluene						90.6	59.4	0.0	3.7	1,536.9	2,420	-0.1	0.0
Total train						127.1	65.6	2.0	16.8	2,115.1	2,420	-0.1	-0.1
Run 7 condensate													
A - $MeCl_2$	96,739		0	13,376	127,976	24.1	0.0	0.0	3.3				
B - $MeCl_2$		10,624,00			127,976	0.0	3,026.5	0.0	0.0				
Avg. - $MeCl_2$						24.1	3,026.5	0.0	3.3	87,037.8	2,420	35.9	20.4
Due to ATT problems, there is only one good value per group of peaks.													
A - Ether		3,369,600			126,320	0.0	850.9	0.0	0.0				
B - Ether		3,946,240		10,880	126,320	0.0	996.6	0.0	2.7				
Avg. - Ether						0.0	923.7	0.0	2.7	26,405.1	2,420	10.7	6.1
Had to use high ATT on this sample, hence smaller peaks were not picked up.													
A - Toluene	118,400	1,303,580	0	8,320	121,636	35.5	390.7	0.0	2.5				
B - Toluene	123,040	1,348,080	0	11,440	121,636	36.9	404.1	0.0	3.4				
Avg. - Toluene						36.2	397.4	0.0	3.0	12,441.5	2,420	4.9	2.8
Total condensate						60.3	4,347.7	0.0	9.0	125,884.4	2,420	51.5	29.2
Run 7 total						187.4	4,413.2	2.0	25.8	127,999.5	2,420	51.3	29.1
Run 8 train													
A - $MeCl_2$	2,489,961	1,611,537	3,627,627	1,487,253	131,068	605.9	392.2	882.8	361.9				
B - $MeCl_2$	2,389,280	1,631,680	3,479,424	1,289,536	131,068	581.4	397.1	846.7	313.8				
Avg. - $MeCl_2$						593.7	394.6	864.7	337.9	21,909.0	2,234	9.7	5.5

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Ether	63,867	24,575	7,216	25,584	134,160	15.2	5.8	1.7	6.1				
B - Ether	63,147	26,831	5,360	23,904	134,160	15.0	6.4	1.3	5.7				
Avg. - Ether						15.1	6.1	1.5	5.9	285.9	2,234	0.0	0.0
A - Toluene	473,642	120,480	0	11,616	132,664	130.2	33.1	0.0	3.2				
B - Toluene	540,627	115,392	0	11,424	132,664	148.6	31.7	0.0	3.1				
Avg. - Toluene						139.4	32.4	0.0	3.2	1,749.4	2,234	0.0	0.0
Total train						748.1	433.1	866.2	346.2	23,944.3	2,234	9.6	5.5
Run 8 condensate													
A - $MeCl_2$	234,990	79,000	26,048	30,016	127,976	66.9	22.5	7.4	8.6				
B - $MeCl_2$	237,848	67,368	25,984	28,128	127,976	67.8	19.2	7.4	8.0				
Avg. - $MeCl_2$						67.3	20.8	7.4	8.3	1,038.9	2,234	0.4	0.2
A - Ether	152,658	211,680	9,568	24,640	134,160	36.3	50.3	2.3	5.9				
B - Ether	165,754	225,872	10,400	25,344	134,160	39.2	53.7	2.5	6.0				
Avg. - Ether						37.7	52.0	2.4	5.9	980.7	2,234	0.2	0.1
A - Toluene	147,200	35,880	0	11,040	121,636	44.1	11.1	0.0	3.3				
B - Toluene	301,843	23,328	0	24,736	121,636	90.5	7.0	0.0	7.4				
Avg. - Toluene						67.3	9.0	0.0	5.4	816.8	2,234	0.1	0.0
Total condensate						172.4	81.9	9.8	19.6	2,836.4	2,234	0.7	0.4
Run 8 total						920.5	515.0	876.0	366.5	26,780.7	2,234	10.3	5.9
Run 9 train													
A - $MeCl_2$	148,549	173,958	20,938	20,555	131,088	36.1	42.3	5.1	5.0				
B - $MeCl_2$	138,965	12,497,976	26,424	46,496	131,088	33.8	3,041.4	6.4	11.3				
Avg. - $MeCl_2$						35.0	1,541.8	5.8	8.2	15,907.5	2,244	6.9	3.9

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Ether	56,528	10,528	8,304	20,544	134,160	13.4	2.5	2.0	4.9				
B - Ether	38,752	14,480	7,824	20,688	134,160	9.2	3.4	1.9	4.9				
Avg. - Ether						11.3	3.0	1.9	4.9	211.2	2,244	-0.1	0.0
A - Toluene	678,342	176,064	0	13,376	132,664	186.4	48.4	0.0	3.7				
B - Toluene	659,655	197,312	0	15,488	132,664	181.3	54.2	0.0	4.3				
Avg. - Toluene						183.8	51.3	0.0	4.0	2,391.2	2,244	0.3	0.2
Total train						230.2	1596.1	7.7	17.0	18,509.8	2,244	7.2	4.1
Run 9 condensate													
A - $MeCl_2$	43,840	14,976	5,552	14,848	127,976	10.9	3.7	1.4	3.7				
B - $MeCl_2$	43,376	14,016	4,896	13,024	127,976	12.4	4.0	1.4	3.7				
Avg. - $MeCl_2$						11.6	3.9	1.4	3.7	817.8	2,244	0.3	0.2
A - Ether	35,416	322,273	5,248	28,224	134,160	8.7	76.6	1.2	6.7				
B - Ether	34,774	311,594	4,768	21,008	134,160	8.3	74.1	1.1	5.0				
Avg. - Ether						8.5	75.4	1.2	5.9	3,607.4	2,244	1.4	0.8
A - Toluene	439,627	11,360	2,400	23,376	121,636	131.8	3.4	0.7	7.0				
B - Toluene	238,297	15,408	2,464	28,656	121,636	80.4	4.6	0.7	8.6				
Avg. - Toluene						106.1	4.0	0.7	7.8	4,709.6	2,244	1.8	1.0
Total condensate						126.2	63.2	3.3	17.4	9,134.8	2,244	3.5	2.0
Run 9 total						356.4	1,679.4	11.0	34.4	27,644.6	2,244	10.7	6.0
Run 10 train													
A - $MeCl_2$	126,512	33,272	16,942	37,378	131,088	30.8	8.1	4.1	9.1				
B - $MeCl_2$	133,928	35,176	14,920	24,376	131,088	32.6	8.6	3.6	5.9				
Avg. - $MeCl_2$						31.7	8.3	3.9	7.5	514.1	2,353	0.1	0.0

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Ether	49,006	9,008	2,496	20,896	134,160	11.7	2.1	0.6	5.0				
B - Ether	51,008	7,840	2,304	17,472	134,160	13.9	2.1	0.6	4.7				
Avg. - Ether						12.8	2.1	0.6	4.9	203.6	2,353	-0.1	0.0
A - Toluene	737,625	155,296	0	19,520	132,664	202.7	42.7	0.0	5.4				
B - Toluene	708,705	169,152	0	19,200	132,664	194.8	46.5	0.0	5.3				
Avg. - Toluene						198.7	44.6	0.0	5.3	2,486.3	2,353	0.3	0.2
Total train						243.2	55.0	4.5	17.7	3,204.0	2,353	0.3	0.2
Run 10 condensate													
A - $MeCl_2$	32,704	7,744	0	11,728	127,976	8.2	1.9	0.0	2.9				
B - $MeCl_2$	35,312	8,672	0	10,816	127,976	8.8	2.2	0.0	2.7				
Avg. - $MeCl_2$						8.5	2.0	0.0	2.8	525.3	2,353	0.1	0.1
A - Ether	22,129	149,151	3,808	26,208	134,160	5.3	35.5	0.9	6.2				
B - Ether	22,487	151,945	4,096	24,048	134,160	5.3	36.1	1.0	5.7				
Avg. - Ether						5.3	35.8	0.9	6.0	1,891.8	2,353	0.6	0.3
A - Toluene	180,870	19,440	2,192	19,792	121,636	54.2	5.8	0.7	5.9				
B - Toluene	89,584	18,544	0	18,464	121,636	26.9	5.6	0.0	5.5				
Avg. - Toluene						40.5	5.7	0.7	5.7	2,073.0	2,353	0.6	0.3
Total condensate						54.3	43.5	1.6	14.5	4,490.1	2,353	1.3	0.8
Run 10 total						297.5	98.6	6.1	32.2	7,694.1	2,353	1.7	1.0
Method blank train													
A - $MeCl_2$	61,808	29,584	2,528	24,112	131,088	15.0	7.2	0.6	5.9				
B - $MeCl_2$	67,600	32,136	1,608	20,128	131,088	16.5	7.8	0.4	4.9				
Avg. - $MeCl_2$						15.7	7.5	0.5	5.4	291.4			

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Ether	60,484	184,208	3,968	25,104	134,160	14.4	43.8	0.9	6.0				
B - Ether	62,120	130,560	4,032	23,456	134,160	14.8	31.0	1.0	5.6				
Avg. - Ether						14.6	37.4	1.0	5.8	587.2			
A - Toluene	581,408	237,408	3,712	31,776	132,664	159.8	65.2	1.0	8.7				
B - Toluene	603,296	228,128	0	24,864	132,664	165.8	62.7	0.0	6.8				
Avg. - Toluene						162.8	64.0	1.0	7.8	2,355.5			
Total train						193.1	108.9	2.5	18.9	3,234.2			
Method blank condensate													
A - $MeCl_2$	28,576	10,496	3,392	42,736	131,088	7.0	2.6	0.8	10.4				
B - $MeCl_2$	33,136	14,464	0	16,048	131,088	8.1	3.5	0.0	3.9				
Avg. - $MeCl_2$						7.5	3.0	0.8	7.2	185.2			
A - Ether	8,082	135,699	4,736	33,152	131,088	2.0	33.0	1.2	8.1				
B - Ether	13,602	135,879	6,088	34,269	131,088	3.3	33.1	1.5	8.3				
Avg. - Ether						2.6	33.0	1.3	8.2	452.0			
A - Toluene	113,406	15,968	3,008	39,392	121,636	34.0	4.8	0.9	11.8				
B - Toluene	126,882	10,192	0	18,496	121,636	38.0	3.1	0.0	5.5				
Avg. - Toluene						36.0	3.9	0.9	8.7	495.1			
Total condensate						46.2	40.0	3.0	24.0	1,132.3			
Method blank total						239.3	148.9	5.5	43.0	4,366.5			
Run 6 blank train													
A - $MeCl_2$	71,680	26,848	4,048	28,896	131,088	17.4	6.5	1.0	7.0				
B - $MeCl_2$	72,144	33,153	6,432	23,296	131,088	17.6	8.1	1.6	5.7				
Avg. - $MeCl_2$						17.5	7.3	1.3	6.4	324.3			

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Ether	49,376	43,248	11,056	59,616	134,160	11.7	10.3	2.6	14.2				
B - Ether	59,530	28,528	5,088	22,352	134,160	14.2	6.8	1.2	5.3				
Avg. - Ether						12.9	8.5	1.9	9.7	331.5			
A - Toluene	319,520	123,616	0	12,544	132,664	87.8	34.0	0.0	3.4				
B - Toluene	311,400	120,256	0	12,224	132,664	85.6	33.0	0.0	3.4				
Avg. - Toluene						86.7	33.5	0.0	3.4	1,236.0			
Total train						117.1	49.3	3.2	19.5	1,891.7			
Run 6 blank condensate													
A - $MeCl_2$	59,968	52,800	0	18,944	131,544	14.5	12.8	0.0	4.6				
B - $MeCl_2$	47,584	42,592	0	17,152	131,544	13.2	11.8	0.0	4.8				
Avg. - $MeCl_2$						13.9	12.3	0.0	4.7	308.4			
A - Ether	8,650	145,526	3,272	36,776	126,320	2.2	36.8	0.8	9.3				
B - Ether	8,841	145,116	2,888	29,504	126,320	2.2	36.6	0.7	7.5				
Avg. - Ether						2.2	36.7	0.8	8.4	480.5			
A - Toluene	281,561	18,848	1,984	29,240	121,636	84.4	5.6	0.6	8.8				
B - Toluene	138,141	21,576	2,320	32,648	121,636	41.4	6.5	0.7	9.8				
Avg. - Toluene						62.9	6.1	0.6	9.3	788.8			
Total condensate						79.0	55.1	1.4	22.3	1,577.7			
Run 6 blank total						196.1	104.4	4.6	41.8	3,469.5			
Run 7 blank train													
A - $MeCl_2$	89,600	60,312	7,224	37,496	131,088	21.8	14.7	1.8	9.1				
B - $MeCl_2$	81,416	58,304	7,840	36,320	131,088	19.8	14.2	1.9	8.8				
Avg. - $MeCl_2$						20.8	14.4	1.8	9.0	460.6			

(continued)

TABLE B-4-6 (continued)

	Total area of peaks				Avg. std. peak[a]	ug/mL as C_{12}				ug[b] total	Liters sampled	Conc. ug/L	ppm as[c] propane
	C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}		C_{7-10}	C_{10-12}	C_{12-14}	C_{14-17}				
A - Ether	53,323	15,184	4,768	25,984	134,160	12.7	3.6	1.1	6.2				
B - Ether	48,352	5,536	2,864	16,032	134,160	11.5	1.3	0.7	3.8				
Avg. - Ether						12.1	2.5	0.9	5.0	204.5			
A - Toluene	473,080	184,544	0	9,408	132,664	130.0	50.7	0.0	2.6				
B - Toluene	388,087	205,193	0	9,984	132,664	106.6	56.4	0.0	2.7				
Avg. - Toluene						118.3	53.6	0.0	2.7	1,745.4			
Total train						151.2	70.4	2.7	16.6	2,410.5			
Run 7 blank condensate													
A - $MeCl_2$	40,784	23,552	2,016	17,648	131,544	11.3	6.5	0.6	4.9				
B - $MeCl_2$	40,336	23,840	0	14,912	131,544	9.8	5.8	0.0	3.6				
Avg. - $MeCl_2$						10.5	6.2	0.6	4.3	215.1			
A - Ether	12,464	273,936	3,328	20,640	126,320	3.1	69.2	0.8	5.2				
B - Ether	11,349	245,004	2,688	17,824	126,320	2.9	61.9	0.7	4.5				
Avg. - Ether						3.0	65.5	0.8	4.9	741.5			
A - Toluene	212,442	23,904	1,736	26,792	121,636	63.7	7.2	0.5	8.0				
B - Toluene	125,005	16,352	1,952	24,456	121,636	37.5	4.9	0.6	7.3				
Avg - Toluene						50.6	6.0	0.6	7.7	648.4			
Total condensate						64.1	77.7	1.9	16.8	1,604.9			
Run 7 blank total						215.3	148.2	4.6	33.4	4,015.5			

[a] Based on 31.9 ug/mL C_{12}.

[b] Based on sample volume of 10 mL.

[c] Conversion of (24.1 uL/umol)/(44 ug/umol) x ug/L of sample.

* Blank corrected value, blanks used were as follows (ug):
Train: $MeCl_2$ = 324.3; Ether = 331.5; Toluene = 1,745.4
Condensate: $MeCl_2$ = 215.1; Ether = 480.5; Toluene = 648.4
Total blank = 3,745.2 ug

TABLE B-4-7. NONVOLATILE ORGANIC ANALYSIS DATA[a]

	Avg. wt. for duplicates (g/mL)	Corrected wt.[b] (µg)
Methylene chloride extracts		
MM5 train		
Run 5	0.00104	8,550
Run 6	0.00159	14,100
Run 7	0.00113	9,500
Run 8	0.00146	12,800
Run 9	0.00057	3,850
Run 10	0.00067	4,800
Blank train 6	0.00088	-
Blank train 7	0.00018	-
Method blank	0.00015	-
Condensate		
Run 5	0.00019	1,737
Run 6	0.00055	5,276
Run 7	-0.00006	-770
Run 8	0.00030	2,750
Run 9	0.00026	2,380
Run 10	0.00047	4,528
Blank train 6	0.00002	-
Blank train 7	0.00002	-
Method blank	-0.00005	-
Ether extracts		
MM5 train		
Run 5	0.00016	-200
Run 6	0.00017	-50
Run 7	0.00013	-400
Run 8	0.00013	-450
Run 9	0.00016	-150
Run 10	0.00014	-300
Blank train 6	0.00018	-
Blank train 7	0.00025	-
Method blank	0.00007	-

(continued)

TABLE B-4-7 (continued)

	Avg. wt. for duplicates (g/mL)	Corrected wt.[b] (µg)
Condensate		
Run 5	0.00028	2,231
Run 6	0.00022	1,620
Run 7	0.00029	2,250
Run 8	0.00011	500
Run 9	0.00034	2,774
Run 10	0.00012	582
Blank train 6	0.00006	-
Blank train 7	0.00011	-
Method blank	0.00005	-
Toluene extracts		
MM5 train		
Run 5	0.00006	-100
Run 6	0.00006	-150
Run 7	0.00010	200
Run 8	0.00009	150
Run 9	0.00006	-150
Run 10	0.00003	-500
Blank train 6	0.00010	-
Blank train 7	0.00007	-
Method blank	0.00007	-
Condensate		
Run 5	0.00019	1,837
Run 6	0.00030	2,860
Run 7	0.00067	6,598
Run 8	0.00014	1,300
Run 9	0.00038	3,671
Run 10	0.00018	1,673
Blank train 6	0.00001	-
Blank train 7	0.00001	-
Method blank	0.00006	-

---

[a] Slight variations in numbers may be present due to computer rounding.

[b] Corrected by subtraction of method blank wt. and multiplication by 10-mL sample volume.

TABLE B-4-8. NONVOLATILE ORGANIC ANALYSIS SUMMARY

	Corrected wt. (µg)	Gas sample volume (L)	Concentration µg/L	Concentration ppm as propane[a]
Run 5 train				
MeCl$_2$	8,550			
Ether	-200			
Toluene	-100			
Subtotal	8,250	2,387	3.5	0.9
Run 5 condensate				
MeCl$_2$	1,737			
Ether	2,231			
Toluene	1,837			
Subtotal	5,805	2,387	2.4	0.7
Run 5 total	14,055	2,387	5.9	1.6
Run 6 train				
MeCl$_2$	14,100			
Ether	-50			
Toluene	-150			
Subtotal	13,900	1,883	7.4	2.0
Run 6 condensate				
MeCl$_2$	5,276			
Ether	1,620			
Toluene	2,860			
Subtotal	9,756	1,883	5.2	1.4
Run 6 total	23,656	1,883	12.6	3.4
Run 7 train				
MeCl$_2$	9,500			
Ether	-400			
Toluene	200			
Subtotal	9,300	2,420	3.8	1.1
Run 7 condensate				
MeCl$_2$	-770			
Ether	2,250			
Toluene	6,598			
Subtotal	8,078	2,420	3.3	0.9
Run 7 total	17,378	2,420	7.2	2.0

(continued)

TABLE B-4-8 (continued)

	Corrected wt. (μg)	Gas sample volume (L)	Concentration μg/L	Concentration ppm as propane[a]
Run 8 train				
$MeCl_2$	12,800			
Ether	-450			
Toluene	150			
Subtotal	12,500	2,234	5.6	1.5
Run 8 condensate				
$MeCl_2$	2,750			
Ether	500			
Toluene	1,300			
Subtotal	4,550	2,234	2.0	0.6
Run 8 total	17,050	2,234	7.6	2.1
Run 9 train				
$MeCl_2$	3,850			
Ether	-150			
Toluene	-150			
Subtotal	3,550	2,244	1.6	0.4
Run 9 condensate				
$MeCl_2$	2,380			
Ether	2,774			
Toluene	3,671			
Subtotal	8,826	2,244	3.9	1.1
Run 9 total	12,376	2,244	5.5	1.5
Run 10 train				
$MeCl_2$	4,800			
Ether	-300			
Toluene	-500			
Subtotal	4,000	2,353	1.7	0.5

(continued)

TABLE B-4-8 (continued)

	Corrected wt. (μg)	Gas sample volume (L)	Concentration μg/L	Concentration ppm as propane[a]
Run 10 condensate				
$MeCl_2$	4,528			
Ether	582			
Toluene	1,673			
Subtotal	6,783	2,353	2.9	0.8
Run 10 total	10,783	2,353	4.6	1.3

[a] Conversion of $\frac{(24.1\ \mu L/\mu mol\ of\ gas)}{(44\ \mu g/\mu mol\ of\ propane)}$

Blank values (μg) as follows:
Train: Methylene chloride = 1,800; Ether = 1,800; Toluene = 700
Condensate: Methylene chloride = 200; Ether = 600; Toluene = 100
Total blank = 5,200

TABLE B-4-9. MM5 DATA SUMMARY

Run	Sample volume (dscm)	Moisture (%)	Isokinetic (%)
5	2.387	60.7	98.9
6	1.883	60.8	82.7
7	2.420	57.2	93.9
8	2.234	57.9	96.7
9	2.244	64.2	94.2
10	2.353	60.9	98.5

TABLE B-4-10. METHOD 3 (Orsat) RESULTS

Run	CO_2 (%)	O_2 (%)
5	8.4	8.0
6	10.5	6.0
7	9.4	7.4
8	9.8	7.6
9	11.4	3.6
10	10.8	6.2

Table B-4-11. MM5 Raw Data

```
FILE NAME - MOBSV5                                         PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 5                               10-01-1988  17:17:15
LOCATION - Mobay Kansas City MO
DATE - 7/28/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=                  716.377
Final Meter Volume (Cubic Feet)=                    805.023
Meter Factor=                                         1.018
Multiple leak checks, see end of printout                   Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                       90.224
Gas Volume (Dry Standard Cubic Feet)=                84.298

Barometric Pressure (in Hg)=                          29.32
Static Pressure (Inches H2O)=                         -0.15

Percent Oxygen=                                         8.0
Percent Carbon Dioxide=                                 8.4
Moisture Collected (ml)=                             2786.4
Percent Water=                                         60.7  **Saturated Stack**

Average Meter Temperature (F)=                           94
Average Delta H (in H2O)=                              0.67
Average Delta P (in H2O)=                             0.674
Average Stack Temperature (F)=                          187

Dry Molecular Weight=                                 29.66
Wet Molecular Weight=                                 22.59

Average Square Root of Delta P (in H2O)=             0.8152
% Isokinetic=                                          98.9

Pitot Coefficient=                                     0.83
Sampling Time (Minutes)=                              192.0
Nozzle Diameter (Inches)=                             0.274
Stack Axis #1 (Inches)=                                35.6
Stack Axis #2 (Inches)=                                35.6
Circular Stack
Stack Area (Square Feet)=                              6.91

Stack Velocity  (Actual, Feet/min)=                   3,447
Flow Rate (Actual, Cubic ft/min)=                    23,826
Flow rate (Standard, Wet, Cubic ft/min)=             19,051
Flow Rate (Standard, Dry, Cubic ft/min)=              7,494

Particulate Loading - Front Half

Particulate Weight (g)=                              0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=              0.0000        0.0000     0.0000
Particulate Loading, Actual (gr/cu ft)=              0.0000
Emission Rate (lb/hr)=                                 0.00

No Back Half Analysis
```

```
                          * * METRIC UNITS * *
FILE NAME - MOBSV5                                            PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 5                                  10-01-1988  17:17:18
LOCATION - Mobay Kansas City MO
DATE - 7/28/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=           20.285
Final Meter Volume (Cubic Meters)=             22.795
Meter Factor=                                   1.018
Multiple leak checks, see end of printout                Leak Correction=  0.0000
Net Meter Volume (Cubic Meters)=                2.555
Gas Volume (Dry Standard Cubic Meters)=         2.387

Barometric Pressure (mm Hg)=                      745
Static Pressure (mm H20)=                          -4

Percent Oxygen=                                   8.0
Percent Carbon Dioxide=                           8.4
Moisture Collected (ml)=                       2786.4
Percent Water=                                   60.7    **Saturated Stack**

Average Meter Temperature (C)=                     35
Average Delta H (mm H20)=                        17.0
Average Delta P (mm H20)=                        17.1
Average Stack Temperature (C)=                     86

Dry Molecular Weight=                           29.66
Wet Molecular Weight=                           22.59

Average Square Root of Delta P (mm H20)=       4.1086
% Isokinetic=                                    98.9

Pitot Coefficient=                               0.83
Sampling Time (Minutes)=                        192.0
Nozzle Diameter (mm)=                            6.96
Stack Axis #1 (Meters)=                         0.904
Stack Axis #2 (Meters)=                         0.904
Circular Stack
Stack Area (Square Meters)=                     0.642

Stack Velocity  (Actual, m/min)=                1,051
Flow rate (Actual, Cubic m/min)=                  675
Flow rate (Standard, Wet, Cubic m/min)=           539
Flow rate (Standard, Dry, Cubic m/min)=           212

Particulate Loading - Front Half

Particulate Weight (g)=                        0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (mg/cu m)=          0.0             0.0        0.0
Particulate Loading, Actual (mg/cu m)=            0.0
Emission Rate (kg/hr)=                           0.00

No Back Half Analysis
```

```
FILE NAME - MOBSV5                                   PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 5                         10-01-1988  17:17:21
LOCATION - Mobay Kansas City MO
DATE - 7/28/88
PROJECT # - 9101L3614

Point #        Delta P    Delta H    Stack T       Meter T
              (in. H2O)  (in. H2O)     (F)      In(F)   Out(F)
  1             0.830       0.77       188        88       88
  2             0.790       1.35       175        88       89
  3             0.820       0.65       188        90       88
  4             0.810       0.76       188        91       89
  5             0.790       0.76       188        92       90
  6             0.810       0.83       187        93       90
  7             0.800       0.78       188        94       91
  8             0.800       0.84       187        94       92
  9             0.810       0.85       187        94       93
 10             0.790       0.85       187        93       93
 11             0.820       0.79       188        95       93
 12             0.810       0.80       188        94       93
 13             0.750       0.77       187        95       94
 14             0.740       0.74       187        96       94
 15             0.740       0.68       188        96       95
 16             0.750       0.76       187        94       95
 17             0.700       0.73       187        94       95
 18             0.700       0.73       187        95       95
 19             0.630       0.63       187        95       96
 20             0.630       0.60       187        95       96
 21             0.520       0.50       187        95       96
 22             0.530       0.50       186        94       95
 23             0.400       0.35       186        94       95
 24             0.390       0.38       186        95       96
 25             0.450       0.45       184        92       92
 26             0.450       0.50       185        91       94
 27             0.520       0.55       187        94       95
 28             0.520       0.52       187        94       95
 29             0.500       0.47       188        94       95
 30             0.480       0.44       187        95       95
 31             0.680       0.66       187        95       95
 32             0.700       0.67       187        95       96
 33             0.720       0.70       187        95       96
 34             0.700       0.71       187        97       97
 35             0.860       0.85       187        98       97
 36             0.840       0.85       187        99       98
 37             0.810       0.82       187        98       98
 38             0.820       0.78       188        98       98
 39             0.810       0.77       188        96       98
 40             0.800       0.76       188        96       98
```

```
FILE NAME - MOBSV5                                              PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 5                                    10-01-1988  17:17:26
LOCATION - Mobay Kansas City MO
DATE - 7/28/88
PROJECT # - 9101L3614

 41           0.750        0.74       187        97        98
 42           0.740        0.75       187        97        98
 43           0.660        0.62       188        97        98
 44           0.670        0.64       187        96        98
 45           0.510        0.50       187        94        97
 46           0.510        0.44       188        93        96
 47           0.330        0.28       187        92        95
 48           0.360        0.28       187        91        95


Fraction                Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                           (g)        (g)       (g)       (g)
DRY CATCH               0.0000     0.0000    0.0000    0.0000
FILTER                  0.0000     0.0000    0.0000    0.0000

Fraction                Final Wt.  Tare Wt.   Vol.     Net Wt.
                           (g)        (g)     (ml)       (g)
PROBE RINSE             0.0000     0.0000     0.0    0.0000
IMPINGERS               0.0000     0.0000     0.0    0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.0030   96.0000
    0.0030   96.0000
```

```
FILE NAME - MOBSV6                                              PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 6                                    10-01-1988  17:18:10
LOCATION - Mobay Kansas City MO
DATE - 7/29/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=                 805.257
Final Meter Volume (Cubic Feet)=                   889.846
Meter Factor=                                        1.018
Multiple leak checks, see end of printout                     Leak Correction=-14.6282
Net Meter Volume (Cubic Feet)=                      71.206
Gas Volume (Dry Standard Cubic Feet)=               66.493

Barometric Pressure (in Hg)=                         29.26
Static Pressure (Inches H20)=                        -0.15

Percent Oxygen=                                        6.0
Percent Carbon Dioxide=                               10.5
Moisture Collected (ml)=                            2284.1
Percent Water=                                        60.8   **Saturated Stack**

Average Meter Temperature (F)=                          94
Average Delta H (in H20)=                             0.60
Average Delta P (in H20)=                            0.614
Average Stack Temperature (F)=                         187

Dry Molecular Weight=                                29.92
Wet Molecular Weight=                                22.67

Average Square Root of Delta P (in H20)=            0.7749
% Isokinetic=                                         82.7

Pitot Coefficient=                                    0.83
Sampling Time (Minutes)=                             192.0
Nozzle Diameter (Inches)=                            0.274
Stack Axis #1 (Inches)=                               35.6
Stack Axis #2 (Inches)=                               35.6
Circular Stack
Stack Area (Square Feet)=                             6.91

Stack Velocity  (Actual, Feet/min)=                  3,274
Flow Rate (Actual, Cubic ft/min)=                   22,632
Flow rate (Standard, Wet, Cubic ft/min)=            18,057
Flow Rate (Standard, Dry, Cubic ft/min)=             7,071

Particulate Loading - Front Half

Particulate Weight (g)=                             0.0000     Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=             0.0000         0.0000     0.0000
Particulate Loading, Actual (gr/cu ft)=             0.0000
Emission Rate (lb/hr)=                                0.00

No Back Half Analysis
```

```
                         * * METRIC UNITS * *
FILE NAME - MOBSV6                                            PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 6                                  10-01-1988  17:18:12
LOCATION - Mobay Kansas City MO
DATE - 7/29/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=            22.802
Final Meter Volume (Cubic Meters)=              25.197
Meter Factor=                                    1.018
Multiple leak checks, see end of printout               Leak Correction= -0.4142
Net Meter Volume (Cubic Meters)=                 2.016
Gas Volume (Dry Standard Cubic Meters)=          1.883

Barometric Pressure (mm Hg)=                       743
Static Pressure (mm H2O)=                           -4

Percent Oxygen=                                    6.0
Percent Carbon Dioxide=                           10.5
Moisture Collected (ml)=                        2284.1
Percent Water=                                    60.8  **Saturated Stack**

Average Meter Temperature (C)=                      34
Average Delta H (mm H2O)=                         15.3
Average Delta P (mm H2O)=                         15.6
Average Stack Temperature (C)=                      86

Dry Molecular Weight=                            29.92
Wet Molecular Weight=                            22.67

Average Square Root of Delta P (mm H2O)=        3.9054
% Isokinetic=                                     82.7

Pitot Coefficient=                                0.83
Sampling Time (Minutes)=                         192.0
Nozzle Diameter (mm)=                             6.96
Stack Axis #1 (Meters)=                          0.904
Stack Axis #2 (Meters)=                          0.904
Circular Stack
Stack Area (Square Meters)=                      0.642

Stack Velocity  (Actual, m/min)=                   998
Flow rate (Actual, Cubic m/min)=                   641
Flow rate (Standard, Wet, Cubic m/min)=            511
Flow rate (Standard, Dry, Cubic m/min)=            200

Particulate Loading - Front Half

Particulate Weight (g)=                         0.0000   Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (mg/cu m)=           0.0         0.0        0.0
Particulate Loading, Actual (mg/cu m)=             0.0
Emission Rate (kg/hr)=                            0.00

No Back Half Analysis
```

```
FILE NAME - MOBSV6                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 6                                10-01-1988  17:18:15
LOCATION - Mobay Kansas City MO
DATE - 7/29/88
PROJECT # - 9101L3614

Point #      Delta P    Delta H    Stack T      Meter T
            (in. H20)  (in. H20)    (F)     In(F)   Out(F)
  1           0.760      0.70       188       82      82
  2           0.810      0.74       188       84      83
  3           0.780      0.74       188       85      84
  4           0.780      0.74       188       88      85
  5           0.780      0.80       187       90      86
  6           0.770      0.75       188       90      87
  7           0.800      0.74       188       91      88
  8           0.750      0.70       188       93      90
  9           0.660      0.60       188       93      90
 10           0.620      0.55       188       94      92
 11           0.550      0.46       188       94      93
 12           0.500      0.46       188       94      93
 13           0.730      0.65       188       95      94
 14           0.700      0.70       187       94      94
 15           0.650      0.65       187       94      94
 16           0.580      0.51       188       96      95
 17           0.710      0.70       187       95      94
 18           0.710      0.71       187       95      95
 19           0.730      0.73       187       96      96
 20           0.700      0.74       186       97      96
 21           0.750      0.85       185       98      97
 22           0.490      0.55       185       98      98
 23           0.430      0.46       184       96      97
 24           0.480      0.52       184       97      97
 25           0.230      0.25       185       89      90
 26           0.240      0.23       187       89      91
 27           0.330      0.33       185       90      91
 28           0.360      0.33       187       91      92
 29           0.420      0.37       187       92      92
 30           0.430      0.45       187       93      93
 31           0.600      0.65       186       94      93
 32           0.610      0.67       186       95      94
 33           0.730      0.80       186       95      95
 34           0.730      0.80       186       94      95
 35           0.800      0.83       186       95      95
 36           0.800      0.85       186       97      96
 37           0.760      0.76       187       97      96
 38           0.750      0.73       187       96      96
 39           0.720      0.70       187       96      96
 40           0.720      0.65       188       97      98
```

```
FILE NAME - MOBSV6                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 6                                10-01-1988  17:18:20
LOCATION - Mobay Kansas City MO
DATE - 7/29/88
PROJECT # - 9101L3614

 41          0.680       0.62      188       97       98
 42          0.660       0.62      187       96       97
 43          0.590       0.59      187       96       97
 44          0.580       0.56      187       96       97
 45          0.460       0.43      188       97       98
 46          0.450       0.45      187       97       98
 47          0.300       0.28      188       96       98
 48          0.290       0.25      187       95       98


Fraction                Final Wt. Tare Wt. Blank Wt. Net Wt.
                           (g)       (g)       (g)      (g)
DRY CATCH              0.0000    0.0000    0.0000    0.0000
FILTER                 0.0000    0.0000    0.0000    0.0000

Fraction                Final Wt. Tare Wt.   Vol.     Net Wt.
                           (g)       (g)     (ml)      (g)
PROBE RINSE            0.0000    0.0000     0.0     0.0000
IMPINGERS              0.0000    0.0000     0.0     0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.1700   96.0000
    0.0010   96.0000
```

```
FILE NAME - MOBSV7                                               PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 7                                     10-01-1988   17:18:55
LOCATION - Mobay Kansas City MO
DATE - 8/1/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=                    891.300
Final Meter Volume (Cubic Feet)=                      982.140
Meter Factor=                                           1.018
Multiple leak checks, see end of printout                        Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                         92.457
Gas Volume (Dry Standard Cubic Feet)=                  85.450

Barometric Pressure (in Hg)=                           29.21
Static Pressure (Inches H2O)=                          -0.15

Percent Oxygen=                                          6.0
Percent Carbon Dioxide=                                 10.5
Moisture Collected (ml)=                              2422.2
Percent Water=                                          57.2

Average Meter Temperature (F)=                            99
Average Delta H (in H2O)=                               0.70
Average Delta P (in H2O)=                              0.663
Average Stack Temperature (F)=                           186

Dry Molecular Weight=                                  29.92
Wet Molecular Weight=                                  23.10

Average Square Root of Delta P (in H2O)=              0.8096
% Isokinetic=                                           93.9

Pitot Coefficient=                                      0.83
Sampling Time (Minutes)=                               192.0
Nozzle Diameter (Inches)=                              0.274
Stack Axis #1 (Inches)=                                 35.6
Stack Axis #2 (Inches)=                                 35.6
Circular Stack
Stack Area (Square Feet)=                               6.91

Stack Velocity  (Actual, Feet/min)=                    3,389
Flow Rate (Actual, Cubic ft/min)=                     23,426
Flow rate (Standard, Wet, Cubic ft/min)=              18,683
Flow Rate (Standard, Dry, Cubic ft/min)=               8,001

Particulate Loading - Front Half

Particulate Weight (g)=                               0.0000     Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=               0.0000          0.0000     0.0000
Particulate Loading, Actual (gr/cu ft)=               0.0000
Emission Rate (lb/hr)=                                  0.00

No Back Half Analysis
```

```
                        * * METRIC UNITS * *
FILE NAME - MOBSV7                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 7                                10-01-1988  17:18:58
LOCATION - Mobay Kansas City MO
DATE - 8/1/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=            25.238
Final Meter Volume (Cubic Meters)=              27.810
Meter Factor=                                    1.018
Multiple leak checks, see end of printout                 Leak Correction=  0.0000
Net Meter Volume (Cubic Meters)=                 2.618
Gas Volume (Dry Standard Cubic Meters)=          2.420

Barometric Pressure (mm Hg)=                       742
Static Pressure (mm H2O)=                           -4

Percent Oxygen=                                    6.0
Percent Carbon Dioxide=                           10.5
Moisture Collected (ml)=                        2422.2
Percent Water=                                    57.2

Average Meter Temperature (C)=                      37
Average Delta H (mm H2O)=                         17.8
Average Delta P (mm H2O)=                         16.8
Average Stack Temperature (C)=                      86

Dry Molecular Weight=                            29.92
Wet Molecular Weight=                            23.10

Average Square Root of Delta P (mm H2O)=        4.0803
% Isokinetic=                                     93.9

Pitot Coefficient=                                0.83
Sampling Time (Minutes)=                         192.0
Nozzle Diameter (mm)=                             6.96
Stack Axis #1 (Meters)=                          0.904
Stack Axis #2 (Meters)=                          0.904
Circular Stack
Stack Area (Square Meters)=                      0.642

Stack Velocity  (Actual, m/min)=                 1,033
Flow rate (Actual, Cubic m/min)=                   663
Flow rate (Standard, Wet, Cubic m/min)=            529
Flow rate (Standard, Dry, Cubic m/min)=            227

Particulate Loading - Front Half

Particulate Weight (g)=                         0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (mg/cu m)=           0.0          0.0         0.0
Particulate Loading, Actual (mg/cu m)=             0.0
Emission Rate (kg/hr)=                            0.00

No Back Half Analysis
```

```
FILE NAME - MOBSV7                                           PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 7                                 10-01-1988  17:19:01
LOCATION - Mobay Kansas City MO
DATE - 8/1/88
PROJECT # - 9101L3614

Point #        Delta P    Delta H     Stack T      Meter T
              (in. H20)  (in. H20)     (F)      In(F)  Out(F)
 1              0.770      0.86        185        91     91
 2              0.780      0.86        186        93     91
 3              0.780      0.86        186        94     92
 4              0.760      0.88        186        97     93
 5              0.810      0.90        186        99     94
 6              0.800      0.90        186        99     95
 7              0.790      0.90        186        99     96
 8              0.780      0.89        186       100     96
 9              0.780      0.83        186       100     97
 10             0.780      0.90        185        99     97
 11             0.770      0.90        185       100     98
 12             0.780      0.89        186       100     98
 13             0.720      0.72        185        99     98
 14             0.740      0.85        185        99     98
 15             0.720      0.83        185        98     98
 16             0.700      0.85        185        99     99
 17             0.680      0.80        185        99     99
 18             0.660      0.77        185       100     99
 19             0.600      0.65        185       100     99
 20             0.600      0.68        184       101    100
 21             0.510      0.61        184       100    101
 22             0.480      0.55        184        99    100
 23             0.320      0.35        182        99    100
 24             0.320      0.35        183        98    100
 25             0.620      0.70        184        97     98
 26             0.600      0.70        184        96     99
 27             0.640      0.75        184        96     98
 28             0.660      0.79        184        99     98
 29             0.740      0.80        186       100     98
 30             0.700      0.75        186       100     99
 31             0.760      0.81        186        98     99
 32             0.740      0.75        187        98     98
 33             0.740      0.72        187        98     98
 34             0.750      0.70        188        99     98
 35             0.810      0.76        188        99     98
 36             0.790      0.79        187       100     99
 37             0.470      0.50        187       102    100
 38             0.680      0.64        188       101    101
 39             0.700      0.60        188       101    101
 40             0.700      0.65        187       101    101
```

```
FILE NAME - MOBSV7                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 7                                10-01-1988  17:19:05
LOCATION - Mobay Kansas City MO
DATE - 8/1/88
PROJECT # - 9101L3614

 41          0.690      0.69     187     101     101
 42          0.660      0.68     187     100     101
 43          0.610      0.58     187     100     101
 44          0.610      0.55     187      99     100
 45          0.520      0.42     190      99     100
 46          0.510      0.32     192      99     100
 47          0.350      0.22     190      98     100
 48          0.360      0.22     190      98     100


Fraction                Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                          (g)        (g)        (g)       (g)
DRY CATCH               0.0000     0.0000     0.0000    0.0000
FILTER                  0.0000     0.0000     0.0000    0.0000

Fraction                Final Wt.  Tare Wt.    Vol.     Net Wt.
                          (g)        (g)       (ml)       (g)
PROBE RINSE             0.0000     0.0000     0.0     0.0000
IMPINGERS               0.0000     0.0000     0.0     0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.0010    96.0000
    0.0030    96.0000
```

```
FILE NAME - MOBSV8                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 8                                10-01-1988  17:19:44
LOCATION - Mobay Kansas City MO
DATE - 8/2/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=               982.836
Final Meter Volume (Cubic Feet)=                1066.560
Meter Factor=                                      1.018
Multiple leak checks, see end of printout                 Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                    85.214
Gas Volume (Dry Standard Cubic Feet)=             78.891

Barometric Pressure (in Hg)=                       29.21
Static Pressure (Inches H2O)=                      -0.15

Percent Oxygen=                                      7.6
Percent Carbon Dioxide=                              9.8
Moisture Collected (ml)=                          2302.4
Percent Water=                                      57.9

Average Meter Temperature (F)=                        97
Average Delta H (in H2O)=                           0.59
Average Delta P (in H2O)=                          0.559
Average Stack Temperature (F)=                       186

Dry Molecular Weight=                              29.87
Wet Molecular Weight=                              23.00

Average Square Root of Delta P (in H2O)=          0.7364
% Isokinetic=                                       96.7

Pitot Coefficient=                                  0.83
Sampling Time (Minutes)=                           192.0
Nozzle Diameter (Inches)=                          0.274
Stack Axis #1 (Inches)=                             35.6
Stack Axis #2 (Inches)=                             35.6
Circular Stack
Stack Area (Square Feet)=                           6.91

Stack Velocity  (Actual, Feet/min)=                3,088
Flow Rate (Actual, Cubic ft/min)=                 21,348
Flow rate (Standard, Wet, Cubic ft/min)=          17,040
Flow Rate (Standard, Dry, Cubic ft/min)=           7,176

Particulate Loading - Front Half

Particulate Weight (g)=                           0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=           0.0000        0.0000     0.0000
Particulate Loading, Actual (gr/cu ft)=           0.0000
Emission Rate (lb/hr)=                              0.00

No Back Half Analysis
```

```
                          * * METRIC UNITS * *
FILE NAME - MOBSV8                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 8                                10-01-1988  17:19:47
LOCATION - Mobay Kansas City MO
DATE - 8/2/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=           27.830
Final Meter Volume (Cubic Meters)=             30.201
Meter Factor=                                   1.018
Multiple leak checks, see end of printout             Leak Correction=  0.0000
Net Meter Volume (Cubic Meters)=                2.413
Gas Volume (Dry Standard Cubic Meters)=         2.234

Barometric Pressure (mm Hg)=                      742
Static Pressure (mm H2O)=                          -4

Percent Oxygen=                                   7.6
Percent Carbon Dioxide=                           9.8
Moisture Collected (ml)=                       2302.4
Percent Water=                                   57.9

Average Meter Temperature (C)=                     36
Average Delta H (mm H2O)=                        15.1
Average Delta P (mm H2O)=                        14.2
Average Stack Temperature (C)=                     85

Dry Molecular Weight=                           29.87
Wet Molecular Weight=                           23.00

Average Square Root of Delta P (mm H2O)=       3.7114
% Isokinetic=                                    96.7

Pitot Coefficient=                               0.83
Sampling Time (Minutes)=                        192.0
Nozzle Diameter (mm)=                            6.96
Stack Axis #1 (Meters)=                         0.904
Stack Axis #2 (Meters)=                         0.904
Circular Stack
Stack Area (Square Meters)=                     0.642

Stack Velocity  (Actual, m/min)=                  941
Flow rate (Actual, Cubic m/min)=                  605
Flow rate (Standard, Wet, Cubic m/min)=           483
Flow rate (Standard, Dry, Cubic m/min)=           203

Particulate Loading - Front Half

Particulate Weight (g)=                        0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (mg/cu m)=          0.0          0.0         0.0
Particulate Loading, Actual (mg/cu m)=            0.0
Emission Rate (kg/hr)=                           0.00

No Back Half Analysis
```

```
FILE NAME - MOBSV8                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 8                                10-01-1988  17:19:50
LOCATION - Mobay Kansas City MO
DATE - 8/2/88
PROJECT # - 9101L3614

Point #      Delta P    Delta H    Stack T      Meter T
            (in. H2O)  (in. H2O)    (F)     In(F)   Out(F)
  1           0.780      0.81       186        84       84
  2           0.780      0.76       187        85       85
  3           0.810      0.79       187        88       86
  4           0.800      0.82       187        91       86
  5           0.800      0.82       187        92       88
  6           0.800      0.82       187        92       89
  7           0.790      0.81       187        92       89
  8           0.790      0.83       186        94       90
  9           0.790      0.78       187        96       92
 10           0.780      0.77       187        96       93
 11           0.680      0.76       185        97       94
 12           0.750      0.75       187        95       95
 13           0.730      0.73       187        96       95
 14           0.750      0.79       186        97       96
 15           0.660      0.70       186        98       96
 16           0.670      0.74       185        99       97
 17           0.660      0.74       185       100       98
 18           0.660      0.70       186       101       99
 19           0.600      0.68       185       102      100
 20           0.570      0.64       185       102      100
 21           0.570      0.62       185       101      101
 22           0.570      0.62       185       100      100
 23           0.400      0.41       185       100      101
 24           0.330      0.35       183        97      100
 25           0.440      0.53       183        95       96
 26           0.410      0.54       182        96       98
 27           0.360      0.40       184        98       98
 28           0.310      0.28       185        97       98
 29           0.260      0.28       184        98       98
 30           0.270      0.28       185        99       99
 31           0.240      0.27       185       101      100
 32           0.200      0.19       185        99      100
 33           0.350      0.36       185        97      100
 34           0.360      0.40       186        98       99
 35           0.420      0.45       186       101      100
 36           0.400      0.42       186       101      101
 37           0.430      0.46       186       102      101
 38           0.420      0.45       186       101      101
 39           0.650      0.69       186       101      102
 40           0.660      0.70       186        98      101
```

```
FILE NAME - MOBSV8                                               PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 8                                     10-01-1988  17:19:54
LOCATION - Mobay Kansas City MO
DATE - 8/2/88
PROJECT # - 9101L3614

 41            0.640       0.68      186      100      101
 42            0.630       0.67      186      100      101
 43            0.580       0.62      186      102      101
 44            0.530       0.63      184      103      102
 45            0.470       0.59      183      102      102
 46            0.520       0.55      186      100      102
 47            0.400       0.45      186      104      103
 48            0.350       0.34      186      101      103


Fraction                Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                           (g)        (g)        (g)       (g)
DRY CATCH             . 0.0000     0.0000     0.0000     0.0000
FILTER                  0.0000     0.0000     0.0000     0.0000

Fraction                Final Wt.  Tare Wt.    Vol.     Net Wt.
                           (g)        (g)      (ml)       (g)
PROBE RINSE             0.0000     0.0000      0.0    0.0000
IMPINGERS               0.0000     0.0000      0.0    0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.0020   96.0000
    0.0030   96.0000
```

```
FILE NAME - MOBSV9                                             PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 9                                   10-01-1988  17:20:29
LOCATION - Mobay Kansas City MO
DATE - 8/3/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=                  66.910
Final Meter Volume (Cubic Feet)=                   151.530
Meter Factor=                                        1.018
Multiple leak checks, see end of printout                    Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                      86.126
Gas Volume (Dry Standard Cubic Feet)=               79.233

Barometric Pressure (in Hg)=                         29.26
Static Pressure (Inches H2O)=                        -0.15

Percent Oxygen=                                        3.6
Percent Carbon Dioxide=                               11.4
Moisture Collected (ml)=                            3014.5
Percent Water=                                        64.2

Average Meter Temperature (F)=                         102
Average Delta H (in H2O)=                             0.61
Average Delta P (in H2O)=                            0.797
Average Stack Temperature (F)=                         191

Dry Molecular Weight=                                29.97
Wet Molecular Weight=                                22.29

Average Square Root of Delta P (in H2O)=            0.8812
% Isokinetic=                                         94.2

Pitot Coefficient=                                    0.83
Sampling Time (Minutes)=                             192.0
Nozzle Diameter (Inches)=                            0.274
Stack Axis #1 (Inches)=                               35.6
Stack Axis #2 (Inches)=                               35.6
Circular Stack
Stack Area (Square Feet)=                             6.91

Stack Velocity  (Actual, Feet/min)=                  3,766
Flow Rate (Actual, Cubic ft/min)=                   26,035
Flow rate (Standard, Wet, Cubic ft/min)=            20,645
Flow Rate (Standard, Dry, Cubic ft/min)=             7,395

Particulate Loading - Front Half

Particulate Weight (g)=                             0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=             0.0000         0.0000     0.0000
Particulate Loading, Actual (gr/cu ft)=             0.0000
Emission Rate (lb/hr)=                                0.00

No Back Half Analysis
```

```
                        * * METRIC UNITS * *
FILE NAME - MOBSV9                                  PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 9                        10-01-1988  17:20:32
LOCATION - Mobay Kansas City MO
DATE - 8/3/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=          1.895
Final Meter Volume (Cubic Meters)=            4.291
Meter Factor=                                 1.018
Multiple leak checks, see end of printout           Leak Correction=  0.0000
Net Meter Volume (Cubic Meters)=              2.439
Gas Volume (Dry Standard Cubic Meters)=       2.244

Barometric Pressure (mm Hg)=                    743
Static Pressure (mm H20)=                        -4

Percent Oxygen=                                 3.6
Percent Carbon Dioxide=                        11.4
Moisture Collected (ml)=                     3014.5
Percent Water=                                 64.2

Average Meter Temperature (C)=                   39
Average Delta H (mm H20)=                      15.5
Average Delta P (mm H20)=                      20.2
Average Stack Temperature (C)=                   88

Dry Molecular Weight=                         29.97
Wet Molecular Weight=                         22.29

Average Square Root of Delta P (mm H20)=     4.4410
% Isokinetic=                                  94.2

Pitot Coefficient=                             0.83
Sampling Time (Minutes)=                      192.0
Nozzle Diameter (mm)=                          6.96
Stack Axis #1 (Meters)=                       0.904
Stack Axis #2 (Meters)=                       0.904
Circular Stack
Stack Area (Square Meters)=                   0.642

Stack Velocity  (Actual, m/min)=              1,148
Flow rate (Actual, Cubic m/min)=                737
Flow rate (Standard, Wet, Cubic m/min)=         585
Flow rate (Standard, Dry, Cubic m/min)=         209

Particulate Loading - Front Half

Particulate Weight (g)=                      0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (mg/cu m)=        0.0          0.0          0.0
Particulate Loading, Actual (mg/cu m)=          0.0
Emission Rate (kg/hr)=                         0.00

No Back Half Analysis
```

```
FILE NAME - MOBSV9                                              PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 9                                    10-01-1988   17:20:35
LOCATION - Mobay Kansas City MO
DATE - 8/3/88
PROJECT # - 9101L3614

Point #       Delta P    Delta H     Stack T        Meter T
             (in. H2O)  (in. H2O)      (F)      In(F)   Out(F)
  1            1.100       0.77        192        95       95
  2            1.100       0.80        192        96       95
  3            1.100       0.84        192        98       95
  4            1.100       0.84        192        99       96
  5            1.150       0.81        192       100       97
  6            1.150       0.88        191       100       97
  7            1.100       0.86        191       102       98
  8            1.100       0.80        192       103       99
  9            1.100       0.78        192       104      101
 10            1.050       0.80        191       102      101
 11            1.050       0.80        191       103      102
 12            1.050       0.82        191       102      102
 13            0.970       0.76        191       102      102
 14            0.970       0.74        191       103      103
 15            0.970       0.74        191       102      103
 16            0.910       0.70        191       102      103
 17            0.880       0.67        191       103      103
 18            0.880       0.66        191       103      103
 19            0.750       0.62        190       103      104
 20            0.750       0.62        190       103      104
 21            0.630       0.52        190       104      103
 22            0.610       0.48        190       102      104
 23            0.440       0.35        189       102      104
 24            0.430       0.34        189       102      104
 25            0.430       0.41        188       103      102
 26            0.480       0.42        189       100      103
 27            0.630       0.52        190       101      103
 28            0.410       0.36        189       101      102
 29            0.700       0.55        190       104      103
 30            0.660       0.50        191       103      103
 31            0.720       0.60        190       104      104
 32            0.670       0.55        190       104      104
 33            0.720       0.55        191       103      104
 34            0.720       0.55        191       104      104
 35            0.530       0.40        191       104      104
 36            0.490       0.37        191       105      105
 37            0.980       0.75        191       105      105
 38            0.980       0.71        191       106      106
 39            0.930       0.76        191       106      105
 40            0.930       0.75        192       106      106
```

```
FILE NAME - MOBSV9                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 9                                10-01-1988  17:20:40
LOCATION - Mobay Kansas City MO
DATE - 8/3/88
PROJECT # - 9101L3614

 41          0.870       0.65      192      105      106
 42          0.870       0.61      192       98       99
 43          0.740       0.52      192       97       98
 44          0.720       0.50      192       99       99
 45          0.540       0.38      192      101       99
 46          0.540       0.35      192      102      100
 47          0.340       0.24      191      102      101
 48          0.320       0.20      191      101      101



Fraction                Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                           (g)        (g)        (g)       (g)
DRY CATCH               0.0000     0.0000     0.0000     0.0000
FILTER                  0.0000     0.0000     0.0000     0.0000

Fraction                Final Wt.  Tare Wt.    Vol.     Net Wt.
                           (g)        (g)      (ml)       (g)
PROBE RINSE             0.0000     0.0000     0.0     0.0000
IMPINGERS               0.0000     0.0000     0.0     0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min)
    0.0010   96.0000
    0.0020   68.0000
    0.0010   28.0000
```

```
FILE NAME - MOBSV10                                         PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 10                               10-01-1988  17:21:13
LOCATION - Mobay Kansas City MO
DATE - 8/8/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Feet)=              152.133
Final Meter Volume (Cubic Feet)=                241.744
Meter Factor=                                     1.018
Multiple leak checks, see end of printout                 Leak Correction=  0.0000
Net Meter Volume (Cubic Feet)=                   91.206
Gas Volume (Dry Standard Cubic Feet)=            83.105

Barometric Pressure (in Hg)=                      29.14
Static Pressure (Inches H2O)=                     -0.15

Percent Oxygen=                                     6.2
Percent Carbon Dioxide=                            10.8
Moisture Collected (ml)=                         2743.7
Percent Water=                                     60.9

Average Meter Temperature (F)=                      105
Average Delta H (in H2O)=                          0.70
Average Delta P (in H2O)=                         0.685
Average Stack Temperature (F)=                      187

Dry Molecular Weight=                             29.98
Wet Molecular Weight=                             22.69

Average Square Root of Delta P (in H2O)=         0.8156
% Isokinetic=                                      98.5

Pitot Coefficient=                                 0.83
Sampling Time (Minutes)=                          192.0
Nozzle Diameter (Inches)=                         0.274
Stack Axis #1 (Inches)=                            35.6
Stack Axis #2 (Inches)=                            35.6
Circular Stack
Stack Area (Square Feet)=                          6.91

Stack Velocity  (Actual, Feet/min)=               3,452
Flow Rate (Actual, Cubic ft/min)=                23,864
Flow rate (Standard, Wet, Cubic ft/min)=         18,957
Flow Rate (Standard, Dry, Cubic ft/min)=          7,419

Particulate Loading - Front Half

Particulate Weight (g)=                          0.0000    Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (gr/scf)=          0.0000         0.0000     0.0000
Particulate Loading, Actual (gr/cu ft)=          0.0000
Emission Rate (lb/hr)=                             0.00

No Back Half Analysis
```

```
                              * * METRIC UNITS * *
FILE NAME - MOBSV10
RUN # - MOBAY ORGANICS RUN 10                                      PROG.=VER 10/01/88 V2
LOCATION - Mobay Kansas City MO                                    10-01-1988  17:21:16
DATE - 8/8/88
PROJECT # - 9101L3614

Initial Meter Volume (Cubic Meters)=                  4.308
Final Meter Volume (Cubic Meters)=                    6.845
Meter Factor=                                         1.018
Multiple leak checks, see end of printout                        Leak Correction=  0.0000
Net Meter Volume (Cubic Meters)=                      2.583
Gas Volume (Dry Standard Cubic Meters)=               2.353

Barometric Pressure (mm Hg)=                            740
Static Pressure (mm H2O)=                                -4

Percent Oxygen=                                         6.2
Percent Carbon Dioxide=                                10.8
Moisture Collected (ml)=                             2743.7
Percent Water=                                         60.9

Average Meter Temperature (C)=                           41
Average Delta H (mm H2O)=                              17.8
Average Delta P (mm H2O)=                              17.4
Average Stack Temperature (C)=                           86

Dry Molecular Weight=                                 29.98
Wet Molecular Weight=                                 22.69

Average Square Root of Delta P (mm H2O)=             4.1107
% Isokinetic=                                          98.5

Pitot Coefficient=                                     0.83
Sampling Time (Minutes)=                              192.0
Nozzle Diameter (mm)=                                  6.96
Stack Axis #1 (Meters)=                               0.904
Stack Axis #2 (Meters)=                               0.904
Circular Stack
Stack Area (Square Meters)=                           0.642

Stack Velocity  (Actual, m/min)=                      1,052
Flow rate (Actual, Cubic m/min)=                        676
Flow rate (Standard, Wet, Cubic m/min)=                 537
Flow rate (Standard, Dry, Cubic m/min)=                 210

Particulate Loading - Front Half

Particulate Weight (g)=                              0.0000     Corr. to 7% O2 & 12% CO2
Particulate Loading, Dry Std. (mg/cu m)=                0.0            0.0          0.0
Particulate Loading, Actual (mg/cu m)=                  0.0
Emission Rate (kg/hr)=                                 0.00

No Back Half Analysis
```

```
FILE NAME - MOBSV10                                          PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 10                                10-01-1988  17:21:18
LOCATION - Mobay Kansas City MO
DATE - 8/8/88
PROJECT # - 9101L3614

Point #       Delta P    Delta H    Stack T      Meter T
            (in. H2O)  (in. H2O)    (F)      In(F)   Out(F)
  1           0.930      0.80       189        95      95
  2           0.870      0.82       188        94      94
  3           0.900      0.95       187        97      94
  4           0.900      0.95       187        98      95
  5           0.890      0.95       188       100      96
  6           0.890      0.97       187       100      97
  7           0.890      0.97       188       102      98
  8           0.910      1.00       187       103      99
  9           0.900      0.95       188       103     100
 10           0.900      0.96       186       103     100
 11           0.880      0.95       187       105     101
 12           0.880      0.95       187       104     102
 13           0.860      0.90       187       104     102
 14           0.850      0.90       188       104     102
 15           0.820      0.82       188       103     103
 16           0.810      0.84       187       103     102
 17           0.780      0.78       187       104     103
 18           0.790      0.74       188       104     103
 19           0.700      0.68       187       104     103
 20           0.690      0.67       187       106     104
 21           0.530      0.55       186       108     105
 22           0.520      0.55       185       110     106
 23           0.320      0.40       183       111     108
 24           0.320      0.35       184       111     109
 25           0.450      0.45       187       106     107
 26           0.450      0.47       187       105     107
 27           0.430      0.45       187       106     107
 28           0.400      0.35       188       107     108
 29           0.320      0.26       188       108     108
 30           0.280      0.25       187       108     108
 31           0.360      0.30       188       107     108
 32           0.360      0.34       187       106     108
 33           0.600      0.60       187       106     108
 34           0.830      0.84       187       107     108
 35           0.840      0.90       187       107     107
 36           0.840      0.95       187       110     108
 37           0.850      0.95       187       110     109
 38           0.890      0.95       188       109     109
 39           0.850      0.90       188       109     109
 40           0.830      0.85       187       110     108
```

```
FILE NAME - MOBSV10                                         PROG.=VER 10/01/88 V2
RUN # - MOBAY ORGANICS RUN 10                               10-01-1988  17:21:23
LOCATION - Mobay Kansas City MO
DATE - 8/8/88
PROJECT # - 9101L3614

 41          0.800       0.81      187      110      109
 42          0.760       0.79      187      109      110
 43          0.660       0.67      187      109      108
 44          0.670       0.59      189      108      108
 45          0.550       0.59      186      108      108
 46          0.520       0.52      187      110      109
 47          0.310       0.27      188      112      110
 48          0.320       0.25      188      110      110


Fraction                 Final Wt.  Tare Wt.  Blank Wt.  Net Wt.
                            (g)        (g)        (g)       (g)
DRY CATCH               0.0000     0.0000     0.0000     0.0000
FILTER                  0.0000     0.0000     0.0000     0.0000

Fraction                 Final Wt.  Tare Wt.    Vol.     Net Wt.
                            (g)        (g)       (ml)       (g)
PROBE RINSE             0.0000     0.0000     0.0      0.0000
IMPINGERS               0.0000     0.0000     0.0      0.0000
Probe Rinse Blank (mg/ml)=  0.0000
Impinger Blank (mg/ml)=  0.0000

Multiple leak checks used.  Final readings for each segment are listed below

Lk Rate (cfm) Time (min).
    0.0010    96.0000
    0.0010    96.0000
```

APPENDIX B-5

FORMALDEHYDE DATA

Table B-5-1. Formaldehyde Results

TABLE B-5-1. FORMALDEHYDE RESULTS

Run	Sample volume (dscm)	µg in sample	Average µg	Blank corrected µg	Blank corrected µg/m³	Blank* corrected ppb (vol)
5	2.359	1.83 1.93	1.88	< 1.88	< 0.80	< 0.64
6	2.837	16.2 16.3	16.3	9.9	3.5	2.8
7	2.593	5.01 4.92	4.97	< 4.97	< 1.9	< 1.5
8	2.584	10.7 10.8	10.8	4.4	1.7	1.4
9	2.611	5.83 6.78	6.31	< 6.31	< 2.4	< 1.9
10	2.539	14.0 13.9	14.0	7.6	3.0	2.4
DNPH Reagent Blank		3.72 3.49 3.82	3.68			
Blank Train		6.41 6.35	6.38			

* $\frac{\mu g}{m^3} \times \frac{24.1\ L}{30\ g} = ppb$

APPENDIX B-6

MOBAY PROCESS DATA

Table B-6-1. Summary Runs 1 through 4
Table B-6-2. Summary Runs 5 through 10
Table B-6-3. Run 1
Table B-6-4. Run 2
Table B-6-5. Run 3
Table B-6-6. Run 4
Table B-6-7. Run 5
Table B-6-8. Run 6
Table B-6-9. Run 7
Table B-6-10. Run 8
Table B-6-11. Run 9
Table B-6-12. Run 10

TABLE B-6-1. MOBAY PROCESS DATA--SUMMARY RUNS 1 THROUGH 4

	Heat input, x 10^{-6} (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas oxygen level, wet[a] (%)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel Natural gas (acfh)	Auxiliary fuel Fuel oil (gpm)	Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Scrubber feed rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Caustic scrubber recycle flow rate (gpm)	Scrubber alkali feed rate (gpm)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
Run 1	26	953	90	3.1	35	6,000	2,600	0	3	6.4	na	47	60	198	50.4	540	1.3	92	7
Run 2	28.8	950	91	1.4	33	6,000	3,270	0	3.3	6.8	2	46	43	196	50.6	530	2	69	7
Run 3	31.9	954	91	2.3	33	6,100	5,770	0	3	6.4	1.9	48	43	196	51	540	1.8	90	7
Run 4	29	954	91	1.9	31	6,030	5,910	0	3	6	2	48	58	195	49	535	1.8	88	7

[a] Conversion for wet to dry basis: $\%O_2$ (dry) = $\%O_2$ (wet)/(1-$\%H_2O$)

TABLE B-6-2. MOBAY PROCESS DATA--SUMMARY RUNS 5 THROUGH 10

	Avg. CO uncorrected (ppm)	Avg. CO @ 7% O_2 (ppm)	THC dry (ppm)	UTHC (ppm)	% O_2 (wet)[a]	Heat input, $\times 10^{-6}$ (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel		Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
											Natural gas (acfh)	Fuel oil (gpm)								
	MRI data					Mobay process data														
Run 5	125	110.9	36.4	3.6	5.3	35.2	865	92	55	7,200	0	0.5	5	13.9	0	48	227	45	68	7.1
Run 6	511	460.2	88	12	5.4	33.2	793	91	443	7,161	4,257	0	4.5	10.7	0	48	222	43	76	7.1
Run 7	1,099	1,068.1	207	7.6	6.6	33.7	802	91	1,693	7,325	0	0	5.6	12.3	2.2	47	214	40	86	7.1
Run 8	2,460	2,464.4	226.8	60.5	7.1	34.1	765	91	3,815	7,250	0	0	5.7	14.4	5	47	212	39	88	7.1
Run 8S	196	167.9	51.2	6.7	4.7	34.5	829	91	73	7,100	4,129	0	4.9	13.4	3.5	47	222	46	81	7.1
Run 9	3,705	2,761.9	199.1	61.4	2.2	41.3	820	93	4,536	6,850	0	0	5	13.4	7.6	48	225	43	74	7.1
Run 10	2,458	2,128.4	85.6	18	4.8	35.7	800	91	3,000	7,000	0	0	6.2	12	7.8	47	225	43	90	7.1

[a] Conversion for wet to dry basis: $\%O_2\ (dry) = \%O_2\ (wet)/(1-\%H_2O)$

TABLE B-6-3. MOBAY PROCESS DATA--RUN 1

							Auxiliary fuel												
Time	Heat input, x 10^{-6} (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas oxygen level, wet[a] (%)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Natural gas (acfh)	Fuel oil (gpm)	Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Scrubber water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Caustic scrubber recycle flow rate (gpm)	Scrubber alkali flow scrubber (gpm)	Scrubber effluent flow scrubber (gpm)	Scrubber effluent (pH)
1150	26	949	90	3.2	34	6,000	2,600	0	3	6.4	NA	46	60	198	50	540	1.3	100	7
1205	26.1	948	90	3.1	32	6,000	2,600	0	3	6.4	NA	47	60	198	50	540	1.3	90	7
1220	26.2	949	90	3.3	34	6,000	2,600	0	3	6.4	NA	46	60	198	50	540	1.3	90	7
1235	26.2	951	90	3	37	5,900	2,600	0	3	6.4	NA	48	60	198	50	540	1.3	90	7
1250	25.1	946	90	3.3	37	5,900	2,600	0	2.9	6.5	NA	46	60	198	50	540	1.3	90	7
1305	26.3	950	90	2.9	42	6,000	2,600	0	3.1	6.4	NA	47	60	198	49	540	1.3	90	7
1320	25.8	953	91	3.1	37	5,900	2,600	0	3	6.4	NA	48	60	198	52	540	1.3	90	7
1455	26.1	951	90	3.2	32	6,000	2,600	0	3	6.4	NA	48	60	198	50	545	1.3	93	7
1510	26	955	91	2.9	29	6,000	2,600	0	3.1	6.4	NA	46	60	198	50	535	1.3	95	7
1525	26.2	955	91	2.9	29	6,000	2,600	0	3.1	6.4	NA	47	60	198	51	540	1.3	93	7
1540	26	955	90	3.1	34	6,100	2,600	0	3.1	6.5	NA	46	60	198	50	535	1.3	95	7
1555	26.1	957	90	3.1	39	6,000	2,600	0	3.1	6.4	NA	47	60	196	51	535	1.3	96	7
1610	26.1	958	91	3.1	37	5,900	2,600	0	3.1	6.4	NA	48	60	198	50	540	1.3	90	7
1625	26	960	91	3	34	6,000	2,600	0	3.1	6.4	NA	47	60	198	52	540	1.3	90	7
Avg:	26.01	952.64	90.36	3.11	35.00	5,978.57	2,600.00	0.00	3.04	6.42	0.00	47.07	60.00	197.86	50.43	539.64	1.30	92.29	7.00

[a] Conversion for wet to dry basis: $\%O_2\ (dry) = \%O_2\ (wet)/(1-\%H_2O)$

TABLE B-6-4. MOBAY PROCESS DATA--RUN 2

Time	Heat input, x 10^{-6} (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas oxygen level, wet[a] (%)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel		Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Scrubber water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Caustic scrubber recycle flow rate (gpm)	Scrubber alkali flow scrubber (gpm)	Scrubber effluent flow scrubber (gpm)	Scrubber effluent (pH)
							Natural gas (acfh)	Fuel oil (gpm)											
1005	30.1	954	92	1.2	1,048	6,000	4,600	0	3.3	6.6	4	46	43	195	52	530	2	66	7
1020	29.4	961	92	1.2	34	6,000	4,000	0	3.3	6.6	2	46	43	195	46	520	2	66	7
1035	28.9	960	92	1.4	32	5,900	3,400	0	3.3	6.7	2	46	43	195	51	520	2	63	7
1050	28.5	956	92	1.4	37	6,100	3,000	0	3.3	6.7	2	46	43	198	49	520	2	63	7
1105	28.5	952	91	1.6	32	6,000	3,000	0	3.3	6.6	2	46	43	198	50	520	2	63	7
1120	28.5	951	91	1.6	34	6,000	3,000	0	3.3	6.6	2	46	43	198	50	530	2	66	7
1135	28.6	955	91	1.6	32	6,000	3,000	0	3.3	6.7	2	46	43	195	51	530	2	75	7
1205	28.6	944	91	1.7	32	6,100	3,000	0	3.3	6.9	2	47	43	195	49	530	2	75	7
1220	28.5	941	91	1.7	32	6,000	3,000	0	3.3	7.2	2	46	43	195	50	530	2	75	7
1235	28.5	941	91	1.4	32	6,000	3,000	0	3.3	7.2	2	46	43	195	50	530	2	75	7
1250	28.5	945	91	1.4	32	6,000	3,000	0	3.3	7.2	2	47	43	195	50	530	2	75	7
1305	28.6	946	91	1.8	29	6,000	3,000	0	3.3	7.2	2	46	43	195	51	530	2	66	7
1320	29	945	91	1.3	37	6,000	3,200	0	3.3	6.6	2	47	43	195	51	530	2	75	7
1335	28.8	945	91	1.5	39	6,000	3,200	0	3.3	6.6	2	47	43	195	51	530	2	66	7
1350	29	948	91	1.4	34	6,000	3,400	0	3.3	6.6	2	47	43	198	52	530	2	72	7
1405	29.1	953	91	1.2	34	6,000	3,400	0	3.3	6.9	2	47	43	198	52	530	2	69	7
1420	29.2	952	91	1.1	29	6,000	3,400	0	3.3	6.9	2	47	43	198	55	530	2	69	7
Avg:	28.84	949.94	91.24	1.44	33.19	6,005.88	3,270.59	0.00	3.30	6.81	2.12	46.41	43.00	196.06	50.59	527.65	2.00	69.35	7.00

[a] Conversion for wet to dry basis: $\%O_2$ (dry)= $\%O_2$ (wet)/(1-$\%H_2O$)

[b] Average for CO does not include first reading at 1,005.

TABLE B-6-5. MOBAY PROCESS DATA--RUN 3

Time	Heat input, $\times 10^{-6}$ (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas oxygen level, wet[a] (%)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel		Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Scrubber water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Caustic scrubber recycle flow rate (gpm)	Scrubber alkali flow scrubber (gpm)	Scrubber effluent flow scrubber (gpm)	Scrubber effluent (pH)
							Natural gas (acfh)	Fuel oil (gpm)											
1115	33.9	947	90	3.6	32	6,100	3,800	0	3	6.4	2	48	43	195	54	530	1.8	90	7
1130	38.9	938	92	1.7	32	5,700	8,200	0	3	6.4	2	48	43	195	51	540	1.8	99	7
1145	38	947	90	2.1	29	6,000	7,600	0	3	6.4	2	47	43	195	51	540	1.8	96	7
1200	37.9	953	91	2.1	32	6,000	7,600	0	3	6.4	2	47	43	195	50	540	1.8	96	7
1215	36	958	91	2	32	6,200	7,600	0	3	6.4	2	47	43	201	54	540	1.8	24	7
1230	37.6	959	91	2.2	37	6,200	7,600	0	3	6.4	2	47	43	198	51	540	1.8	81	7
1245	38.1	961	91	2	37	6,100	7,600	0	3	6.4	2	48	43	198	49	540	1.8	90	7
1300	28.4	958	91	2.1	34	6,200	5,000	0	3	6.4	2	47	43	195	50	540	1.8	130	7
1315	28.4	958	91	2.5	34	6,100	5,000	0	3	6.4	2	48	43	195	50	540	1.8	90	7
1330	28.2	958	91	2.6	34	6,000	4,600	0	3	6.4	2	47	43	198	50	540	1.8	99	7
1345	28.3	954	91	2.4	37	6,200	4,600	0	3	6.4	2	47	43	198	51	540	1.8	87	7
1400	28	957	91	2.3	37	6,200	4,800	0	3	6.4	2	48	43	195	50	540	1.8	93	7
1415	28.2	957	91	2.4	32	6,000	4,800	0	3	6.4	2	47	43	195	54	540	1.8	90	7
1430	28.4	955	91	2.4	32	6,000	4,800	0	3	6.4	1.5	48	43	195	53	540	1.8	93	7
1445	28.3	949	90	2.1	34	6,200	4,800	0	3	6.4	1.5	47	43	195	50	540	1.8	90	7
1500	28.3	955	91	2.3	29	6,200	4,800	0	3	6.4	2	48	43	195	53	540	1.8	90	7
1515	26.7	954	90	2.5	34	6,000	4,800	0	3	6.4	2	48	43	195	50	540	1.8	90	7
Avg:	31.86	954.00	90.82	2.31	33.41	6,082.35	5,764.71	0.00	3.00	6.40	1.94	47.47	43.00	196.06	51.24	539.41	1.80	89.88	7.00

---

[a] Conversion for wet to dry basis: $\%O_2\ (dry) = \%O_2\ (wet)/(1-\%H_2O)$

TABLE B-6-6. MOBAY PROCESS DATA--RUN 4

Time	Heat input, x 10^{-6} (Btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas oxygen level, wet[a] (%)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel		Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Scrubber water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Caustic scrubber recycle flow rate (gpm)	Scrubber alkali flow scrubber (gpm)	Scrubber effluent flow scrubber (gpm)	Scrubber effluent (pH)
							Natural gas (acfh)	Fuel oil (gpm)											
920	29.8	953	91	1.7	24	5,900	7,000	0	3	5.6	2	48	58	198	52	530	1.8	84	7
935	29.4	953	91	2.1	27	6,000	6,400	0	3	5.6	2	47	58	198	47	530	1.8	81	7
950	29.3	957	91	1.8	20	6,000	6,400	0	3	5.6	2	47	58	195	49	540	1.8	90	7
1005	28.8	949	91	1.7	27	6,000	5,600	0	3	6.5	2	48	58	195	48	530	1.8	87	7
1020	29.1	947	91	1.8	32	6,200	6,200	0	3	6.4	2	47	58	195	49	530	1.8	90	7
1035	29.3	949	91	1.8	29	6,000	6,200	0	3	6.4	2	47	58	195	49	535	1.8	90	7
1050	29.3	955	91	1.8	32	6,200	6,200	0	3	6.4	2	49	48	195	48	535	1.8	87	7
1105	29.1	954	91	1.9	29	6,000	6,000	0	3	6.4	2	48	58	195	49	535	1.8	87	7
1120	29.2	956	91	2.1	29	6,000	6,000	0	3	6.4	2	47	58	195	51	535	1.8	87	7
1135	29.5	957	91	1.7	37	6,100	6,200	0	3	6.4	2	49	58	195	90	540	1.8	78	7
1150	29.3	961	91	1.7	34	6,000	6,000	0	3	6.4	2	47	58	195	49	540	1.8	90	7
1205	28.8	955	91	1.9	32	6,000	5,600	0	3	6.4	2	48	58	195	49	530	1.8	90	7
1220	28.7	954	91	1.6	37	6,200	5,600	0	3	5.6	2	47	58	195	48	530	1.8	93	7
1235	28.7	956	91	1.9	29	6,100	5,600	0	3	5.6	2	48	58	195	48	530	1.8	90	7
1250	28.9	959	91	1.8	32	6,000	5,800	0	3	5.6	2	48	58	195	49	535	1.8	90	7
1305	28.3	956	91	2	34	6,000	5,200	0	3	5.6	2	46	58	192	48	535	1.8	90	7
1320	28.2	953	91	2.2	32	6,000	5,200	0	3	5.6	2	47	58	192	50	535	1.8	90	7
1335	28.3	950	91	2	34	5,800	5,200	0	3	5.6	2	47	58	192	49	540	1.8	90	7
Avg:	29.00	954.11	91.00	1.86	30.56	6,027.78	5,911.11	0.00	3.00	6.01	2.00	47.50	58.00	194.83	49.00	534.17	1.80	88.00	7.00

[a] Conversion for wet to dry basis: $\%O_2$ (dry)= $\%O_2$ (wet)/(1-$\%H_2O$)

TABLE B-6-7. PROCESS DATA--RUN 5

	Heat input, x 10^{-6} (btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel, oil (gpm)	Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
1415	34.2	854	92	55	7,150	0.4	5	12.6	0	47	231	46	48	7.1
1430	34.2	850	92	65	7,200	0.5	5	12.6	0	48	225	46	60	7.1
1445	34.6	866	92	35	7,150	0.5	5	12.6	0	48	225	46	72	7.1
1500	34.6	865	92	30	7,100	0.5	5	13.3	0	47	225	46	60	7.1
1515	34.9	864	92	40	7,100	0.5	5	13.3	0	47	228	47	69	7.1
1530	35.3	864	93	55	7,100	0.5	5	13.9	0	48	228	47	75	7.1
1545	35.4	866	93	60	7,100	0.5	5	14.1	0	48	228	48	75	7.1
1600	36.6	870	93	45	7,150	0.5	5.1	14.4	0	47	225	44	75	7.1
1615	35.8	865	93	55	7,200	0.5	5	14.6	0	48	225	43	72	7.1
1630	35.4	863	93	60	7,200	0.5	5	14.6	0	47	225	44	60	7.1
1645	35.4	873	93	62	7,200	0.5	5	14.6	0	46	228	44	66	7.1
1700	35.6	873	92	70	7,200	0.5	5	14.6	0	48	228	44	66	7.1
1715	35.4	871	92	65	7,200	0.5	5	14.6	0	49	228	45	69	7.1
1730	35.2	872	92	75	7,300	0.5	5	14.6	0	48	225	43	84	7.1
Avg:	35.19	865.43	92.43	55.14	7,167.86	0.49	5.01	13.89	0.00	47.57	226.71	45.21	67.93	7.10

TABLE B-6-8. PROCESS DATA--RUN 6

	Heat input, x 10^{-6} (btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel, gas (acfh)	Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
1348	33	806	92	370	7,100	4,800	4.4	10.7	NA	47	222	43	87	7.1
1402	33	806	92	340	7,000	4,800	4.4	10.7	NA	47	219	44	75	7.1
1417	33.1	800	92	310	7,200	4,800	4.4	10.7	NA	48	222	43	81	7.1
1432	32.9	795	91	390	7,200	4,600	4.4	10.7	NA	49	222	43	72	7.1
1449	32.7	795	91	400	7,300	4,600	4.4	10.7	NA	48	222	43	75	7.1
1505	32.8	792	91	500	7,100	4,000	4.5	10.7	NA	48	222	43	72	7.1
1521	33	793	91	610	7,150	4,000	4.5	10.7	NA	47	225	42	72	7.1
1556	32.9	785	91	630	7,300	4,000	4.6	10.7	NA	48	222	41	78	7.1
1610	33.5	787	91	390	7,150	4,000	4.6	10.7	NA	48	219	42	90	7.1
1625	33.4	789	91	470	7,150	4,000	4.6	10.7	NA	47	222	43	72	7.1
1640	33.5	789	91	490	7,200	4,000	4.6	10.7	NA	47	225	44	54	7.1
1655	33.4	791	91	390	7,100	4,000	4.6	10.7	NA	48	225	43	84	7.1
1710	33.4	789	91	410	7,200	4,000	4.6	10.7	NA	48	222	42	75	7.1
1725	33.8	786	91	500	7,100	4,000	4.6	10.7	NA	48	222	43	91	7.1
Avg:	33.17	793.07	91.21	442.86	7,160.71	4,257.14	4.51	10.70	6.50[a]	47.71	222.21	42.79	76.29	7.10

[a] Average obtained from Mobay.

TABLE B-6-9. PROCESS DATA--RUN 7

	Heat input, x 10^{-6} (btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel, gas (acfh)	Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
1105	33.8	809	91	1,500	7,300	0	5.6	12.3	2.2	48	219	40	81	7.1
1122	33.6	805	91	1,350	7,400	0	5.6	12.3	2.2	47	219	40	87	7.1
1137	33.6	805	91	1,750	7,350	0	5.6	12.3	2.2	48	213	40	84	7.1
1150	33.8	804	91	1,650	7,300	0	5.6	12.3	2.2	47	225	44	21	7.1
1205	33.8	800	91	1,700	7,300	0	5.6	12.3	2.2	47	225	41	72	7.1
1222	33.7	799	90	1,850	7,300	0	5.6	12.3	2.2	47	219	40	72	7.1
1235	33.6	799	91	1,850	7,300	0	5.6	12	2.2	48	216	40	66	7.1
1250	33.6	801	90	1,700	7,350	0	5.6	12.1	2.2	48	204	39	90	7.1
1305	33.5	804	91	1,400	7,350	0	5.6	12.1	2.2	48	186	37	190	7.1
1320	33.7	802	91	1,600	7350	0	5.6	12.2	2.3	48	180	37	81	7.1
1335	33.9	801	91	1,800	7,400	0	5.6	12.5	2.2	47	225	42	105	7.1
1350	33.8	799	91	1,900	7,300	0	5.6	12.3	2.2	48	222	40	90	7.1
1405	33.7	796	91	1,800	7,350	0	5.6	12.3	2.1	47	222	41	81	7.1
1420	33.8	797	91	1,850	7,350	0	5.6	12.3	2	46	219	40	84	7.1
Avg:	33.71	801.50	90.86	1,692.86	7,335.71	0.00	5.60	12.26	2.19	47.36	213.86	40.07	86.00	7.10

TABLE B-6-10. PROCESS DATA--RUN 8

	Heat input, x 10^{-6} (btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel, gas (acfh)	Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
950	34.1	792	91	3,700	7,300	0	5.7	13.4	4.9	47	210	38	78	7.1
1005	34.1	786	91	4,100	7,100	0	5.7	14.2	4.8	47	210	37	75	7.1
1020	34.3	783	91	4,100	7,300	0	5.7	14.2	4.9	47	207	37	75	7.1
1035	33.8	776	90	4,200	7,400	0	5.7	14.2	4.9	48	159	32	123	7.1
1050	34.1	769	91	4,100	7,200	0	5.7	13.9	4.9	47	222	41	45	7.1
1105	34	772	91	3,100	7,150	0	5.7	14.2	4.9	48	222	40	159	7.2
1119	34.1	764	91	4,400	7,300	0	5.7	14.6	4.8	47	222	40	90	7.1
1133	34	759	91	4,350	7,200	0	5.7	14.4	4.9	47	219	41	63	7.1
1157	34.2	747	90	3,500	7,300	0	5.7	14.7	4.8	48	216	39	81	7.1
1210	34.3	750	91	3,750	7,300	0	5.7	14.7	4.9	48	216	40	90	7.1
1224	34.2	748	90	3,550	7,350	0	5.7	14.7	4.9	47	219	39	89	7.2
1245	34.3	749	90	2,100	7,250	0	5.7	15	5	46	219	38	90	7.3
1300	34.3	745	91	4,650	7,100	0	5.7	14.6	5.8	48	219	42	87	7
Avg:	34.13	764.62	90.69	3,815.38	7,250.00	0.00	5.70	14.37	4.95	47.31	212.31	38.77	88.08	7.12
Run 8S														
1441	34.5	831	91	67.2	7,100	4,000	4.9	13.4	3.6	46	222	46	84	7.1
1446	34.4	831	91	70.6	7,100	4,100	4.9	13.4	3.5	47	222	47	81	7.1
1451	34.5	829	91	69.1	7,100	4,200	4.9	13.4	3.5	48	222	46	75	7.1
1456	34.6	829	91	72.8	7,100	4,200	4.9	13.4	3.5	47	222	46	81	7.1
1501	34.5	829	91	71.1	7,100	4,200	4.9	13.4	3.5	47	222	47	81	7.1
1506	34.7	828	92	79.6	7,100	4,100	4.9	13.4	3.6	47	222	47	81	7.1
1510	34.4	830	91	80.3	7,100	4,100	4.9	13.4	3.5	47	222	46	81	7.1
Avg:	34.51	829.57	91.14	72.96	7,100.00	4,128.57	4.90	13.40	3.53	47.00	222.00	46.43	80.57	7.10

TABLE B-6-11. PROCESS DATA--RUN 9

	Heat input, x 10^{-6} (btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel, gas (acfh)	Organic waste feed rate (gpm)	Aqueous waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
1220	41.1	827	93	4,700	6,800	0	NA	13.4	7	47	231	44	45	7.1
1235	41.3	827	93	4,500	6,850	0	NA	13.3	7	48	225	43	72	7.2
1250	41.4	829	93	4,950	6,850	0	NA	13.3	7	48	225	43	60	7.2
1305	41.4	830	93	4,700	6,850	0	NA	13.3	7	47	225	43	78	7.1
1320	41.3	831	93	4,500	6,900	0	NA	13.3	7	48	225	43	102	7.1
1335	41.3	831	93	3,500	6,900	0	NA	13.3	7	47	225	43	99	7.1
1350	41.2	824	93	5,100	6,850	0	NA	13.4	7.6	48	225	44	66	7.1
1405	41.1	820	96	4,200	6,850	0	NA	13.4	7.7	748	225	43	75	7.1
1423	41.4	812	96	4,900	6,850	0	NA	13.4	8.3	48	225	42	72	7
1435	41.3	814	93	4,350	6,850	0	NA	13.4	8	47	225	43	66	7
1450	41.2	814	93	4,000	6,900	0	NA	13.4	8	47	225	43	81	7.1
1511	41.2	808	93	4,900	6,850	0	NA	13.4	8.1	47	225	43	75	7.1
1551	41.3	806	94	4,800	6,850	0	NA	13.4	8.1	48	222	43	72	7.2
1606	41.2	805	94	4,400	6,850	0	NA	13.4	8.1	48	222	43	72	7.1
Avg:	41.26	819.86	93.57	4,535.71	6,857.14	0.00	7.30[a]	13.36	7.56	47.57	225.00	43.07	73.93	7.11

[a] Average value obtained from Mobay.

TABLE B-6-12. PROCESS DATA--RUN 10

	Heat input, x 10^{-6} (btu/h)	Combustion chamber temperature (°C)	Quench outlet gas temp. (°C)	Flue gas CO level (ppm)	Combustion air (lean gas) flow rate (acfm)	Auxiliary fuel, gas (acfh)	Organic waste feed rate (gpm)	Slurry (aqueous) waste feed rate (gpm)	Tempering water flow rate (gpm)	Quench water flow rate (gpm)	Venturi inlet water flow rate (gpm)	Venturi pressure drop (in)	Scrubber effluent flow rate (gpm)	Scrubber effluent (pH)
1135	35.2	803	91	3,100	7,000	0	6.1	12	7.7	48	225	42	90	7.1
1150	35.4	800	91	2,950	7,050	0	6.1	12	7.8	47	225	42	81	7.1
1205	35.5	800	91	2,800	7,000	0	6.1	12	7.8	48	225	43	81	7.1
1222	35.8	798	91	3,250	6,950	0	6.1	12	7.9	47	225	44	81	7.1
1236	35.4	796	91	2,700	7,100	0	6.1	12	7.8	47	222	42	90	7.1
1251	34.9	795	91	3,100	7,000	0	6.1	12	7.8	47	228	43	78	7.1
1305	35.3	797	91	3,100	7,000	0	6.1	12	7.8	47	231	43	60	7.1
1333	36	801	91	3,000	7,000	0	6.3	12	7.5	46	222	42	105	7.1
1351	35.7	801	91	2,900	7,000	0	6.3	12	7.8	48	225	44	75	7.1
1405	36.3	801	91	2,800	7,050	0	6.4	12	7.8	48	228	43	75	7.1
1420	36.2	802	91	3,000	7,000	0	6.3	12	7.9	47	228	43	111	7.1
1439	36.5	800	91	3,150	7,000	0	6.3	12	8	48	225	43	138	7.1
1455	36.2	802	91	3,000	7,000	0	6.3	12	7.9	47	225	44	100	7.1
Avg:	35.72	799.69	91.00	2,988.46	7,011.54	0.00	6.20	12.00	7.81	47.31	225.69	42.92	89.62	7.10